



In search of cost-effective measures

Danish report on the use of cost-effectiveness analysis when implementing the EU Water Framework Directive

Jacobsen, Brian H.

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Report No. 191

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*Danish report on the use of cost-effectiveness analysis
when implementing the
EU Water Framework Directive*

Jagten på omkostningseffektive virkemidler
- Anvendelse af omkostningseffektivitetsanalysen ved
implementering af Vandrammedirektivet

Brian H. Jacobsen

Copenhagen 2007

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Preface

This report is the part of several reports prepared for the Committee for long term planning of the Aquatic environment. The aim of the committee is to examine the methods used for economic analyses, the required measures and the potential costs of implementing the Water Framework Directive in Denmark.

The Committee consists of Niels Gotfredsen and Nanna Meilbak (Ministry of Finance), Lars Hansen (Ministry of Food and Agriculture), Mads Leth-Petersen (Ministry of Environment and Energy), Karsten Skov and Mogens B. Kaarsgaard (Danish Environmental Protection Agency) and Sune I. Schou (Danish Forestry and Protection Agency).

The work in the overall project has been divided into 6 sub-groups. This report is prepared by the sub-group on Methods for cost-effectiveness analysis. The report is written by Senior Researcher Brian H. Jacobsen, Division of Environment and Regional Development at the Institute of Food and Resource Economics at Copenhagen University. The author wishes to thank Stuart D. Wright for comments to previous versions of this report. The report has prior to publication been discussed in the Committee for long-term planning of the Aquatic environment.

Director General Søren E. Frandsen
Institute of Food and Resource Economics
Copenhagen, June 2007

Summary

When implementing the Water Framework Directive (WFD), one of the major tasks is to find measures which can insure that the targets are reached. The cost effectiveness analysis (CEA) provides a method for choosing the most cost-effective measures for each River Basin.

The cost effectiveness ranking of measures is straight forward when there is only one target and only one pollutant. However, the case studies in Denmark, and the recommendations from other EU countries, described in this report show that finding the most cost-efficient package of measures is not easy with multiple objectives, side effects and pollutants.

The analysis in this report is based on the official EU guidelines, Danish experiences on River Basin Planning, and findings in Handbooks from other EU member states concerning key areas where further clarification might be needed with respect to CEA analysis. In the report the recommendations are discussed and related to a Danish perspective. The report is part of a larger study for the Committee for the long-term planning of the Aquatic Environment which is chaired by the Danish Ministry of Finance.

The official guidelines on cost estimates from previous EU working groups are found not to provide a very clear description of what exactly to include in the cost estimations. It is concluded that two main types of costs have to be estimated, the social (welfare) costs and the financial (budgetary) costs. The social costs aim to describe the costs of measures for the society, whereas the financial costs describe who is paying the costs. These two types of costs are used in most European analyses. The survey shows that it is important to describe exactly how the costs are calculated. In the previous work related to the WFD the focus has been on how to define environmental resource costs, which can be seen as loss of benefits. These costs are normally related to cost recovery in relation to water services and they are not included in the cost definition used here.

In the Danish calculations the standard costs and income changes will be included (both running costs and investments). The cost-efficiency is calculated as the annual costs divided by the effectiveness. With respect to discounting, the rate of interest is important. The current real rate of interest of 6% is to be used for both social and budgetary calculations in Denmark. A sensitivity analysis using 3% is suggested. In

the calculation of the welfare economic costs, the factor prices are transformed to consumer prices using a factor of 1.17 or 1.25 depending on whether goods are traded nationally or internationally. Furthermore, a tax distortion factor of 20% might be used when the measures rely on public spending and tax funding.

Side effects or additional effects covering e.g. ammonia, CO₂ and other benefits might be included in the calculations. These effects are not the target in the WFD, but could be targeted in other national or European legislations. Special care has to be taken to insure that a specific side effect is calculated and valued for all measures so that data availability does not influence the ranking. It is recommended that the ranking of measures both with and without side effects are shown. Wider economic effects will typically not be included in sub-basin analyses, but might be included in analyses which cover a large area. Finally, the administrative costs will probably not be included in the calculations at the regional level, but some general levels of administrative costs might be used when comparing area-related measures with other types of measures.

Experience from previous Danish policies has shown that it takes longer than anticipated to reach the environmental targets. The effects and costs for previous Aquatic Programmes have been evaluated, and this will allow for better estimations of the cost efficiency in the future. The focus in Denmark has until now been on the N-leaching from the root zone, but in future analyses, the nutrient loss to the recipient will be the key point. This will make the estimations more difficult as there is a larger variation in how much of the nutrients are retained on the way to the recipient. In some cases, it will take more than 10 years for measures to have an effect on the recipient.

The use of CEA in Denmark at the national level has shown that cost-effectiveness ranking can provide the basis for decisions, but the final choice is a political decision. It is likely that this will also be the case when implementing River Management Plans at the local level.

The analyses in Denmark have also shown that:

- It is important to make a clear link between the objective and the means for a given measure. Furthermore, relations and interactions between measures can influence both efficiency and costs.
- That the administrative implementation of a given measure can change both cost and efficiency.

- That the River Management Plans seek to meet targets both with respect to groundwater and water quality in streams, lakes and fjords.
- That CEA analysis at the River Basin Level is a long process where the process of finding measures will have to be evaluated several times (2-3 years is likely).
- That a step-by-step procedure might be recommended to reach a cost-effective River Basin Plan which is also transparent for stakeholders. This means e.g. to start by looking at ground water, then lakes and then fjords.
- That the geographical position of measures might change both efficiency and cost.
- That the key indicator has been nutrient losses. In relation to the WFD the focus is on water flow in streams, phosphorus (P) in lakes and N+P losses to the fjords. It is possible that eutrophication equivalents will be the future key indicators. Water shortage is less of a problem in Denmark.
- It has been found that a majority of streams, lakes and fjords will probably not be able to meet the targets before the deadline in 2015. If there is a gap between current status and the aim for all waterbodies then the use of general measures might be considered. In cases of a variation in gaps between waterbodies the focus will have to be on the regional measures and their site-specific location.

At the European level, the main challenges with respect to carrying out CEA analyses in relation to WFD are found to be:

- How to deal with up-stream and down-stream issues both in terms of environmental effect and distribution of costs of measures among local municipalities, regions and countries.
- That the first water plans might not include proper CEA analyses due to limited availability of data and methods.

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- That a detailed description of both the measure (what behaviour is changed) and the mechanism (what is actually done) is required in order to calculate effect and costs. The interaction between measures is important to consider.
- That the focus in WFD has to be on the supplementary measures, but in some cases the basic measures, like Action Plan III in Denmark, might be relevant to include in analyses regarding disproportionate costs as it has the WFD as the main focus.
- The fulfilment of e.g. the nitrate directive and the Habitat directive might be difficult to separate from the WFD activities, and might also influence the costs of additional measures.
- The pre-screening of measures seems important in countries where the measures are evaluated in pairs based on a long range of parameters.
- The costs definitions vary from country to country, so it is important to describe whether tax conditions, side effects and administrative costs are included in the analysis.
- Some times the intentions in handbooks do not match what is actually used in case studies. The ambitions in guidelines should match what is possible to accomplish at the River Basin level.
- A national catalogue of measures and costs is a recommend first step, but the cost and the effect might vary considerably within countries.
- Some countries focus on nutrient losses whilst others find that using one indicator is too narrow adopting an approach with several indicators.
- The ranking of the cost-efficient measures is, in some cases, based on many parameters, but often the trade offs between the many indicators is not very explicit. The trade offs and the weights associated with each indicator will have to be shown explicitly to accommodate stakeholder participation.
- With respect to uncertainty, an interval seems the most likely, whereas a probability distribution seems to require too much data. Sensitivity analysis

for key parameters is recommended to see how robust the ranking of measures is.

- The involvement of experts and the general public requires that the results are discussed during the River Management Planning process. This takes time, but can help to provide a better understanding and acceptance of the measures which need to be implemented, especially locally.

There will not be a uniform EU approach to the use of CEA in the WFD in the near future, but it is important that the work carried out by the CEA group under the Common Implementation Strategy is continued in order to facilitate the implementation of CEA according to the WFD. With more handbooks and practical experiences, it will be possible to establish some minimum requirement for the CEA analysis. It is concluded that the Danish cost approach is acceptable, compared to other EU countries.

It is recommended that the implementation of CEA in Denmark be divided into two phases, where the first is aimed at getting the data in place and assessing the likely measures for groundwater, streams, lakes and fjords separately at the river basin level. This could be done for 20-25 River Basin areas in Denmark and this would give a first estimate of the actual costs of reaching the targets, based on regional analysis.

The second phase will then involve the more detailed analysis and site specific planning of measures at the sub basin level, where all interrelations between measures and targets are addressed.

In light of the task ahead and the relative short time frame, more effort has to be made to further discuss how the practical CEA at the River Basin level should be performed. Guidelines for people working in this area at the regional level will be required in 2007. It would also be useful for Denmark to actively participate in the future CEA process at the EU level, as this work will be a central issue in relation to the future use of cost-benefit analysis and the issue of disproportionate costs in relation to the WFD.

1. Introduction

1.1. Background

The Water Framework Directive (WFD) (2000/60/EC) was implemented in Denmark by the “Miljømålsloven” in 2003 (EC, 2000; Folketinget, 2003). The main aim of the WFD is to improve the water quality in Europe and the target is described as “good ecological status”, which should be reached by 2015.

The economic analysis is central to several of the analyses required in the WFD and the directive integrates economics into water management and policy making e.g. by using economic principles such as the “polluter pays principle” and methods such as cost-effectiveness analysis (WATECO, 2003). An informal working group called WATECO (WATER ECONomics) has worked on the economic analysis required in the WFD and their guidance document provides the first description of the economic methods and analyses required.

The analyses consist of three types of economic analysis. Firstly, member states have to conduct an analysis of the cost of providing water for consumers and an assessment of whether consumers pay the full cost. Secondly, a cost-effectiveness analysis is required to ensure that the selected measures achieve the environmental targets at the lowest cost. Thirdly, cost-benefit analysis is used to examine whether it will be too costly to reach some targets compared with the benefits which will be obtained.

The focus of this report is cost-effectiveness analysis (CEA), whereas the use of cost-benefit analysis (CBA) in the implementation of the WFD in Denmark is described in Hasler et al. (2007). Both analyses are part of a project for the Committee for long term planning of the Aquatic environment. The aim of the committee is to examine the economic methods, the required measures and estimate the potential costs of implementing the WFD in Denmark. The work in the project is carried out by the National Environment Research Institute (NERI), the Faculty of Agricultural Sciences (DJF) both under the University of Aarhus and the Institute of Food and Resource Economics (FOI) under the University of Copenhagen.

1.2. Purpose

CEA is an appraisal technique that provides a ranking of alternative measures on the basis of their relative costs and effects towards achieving a political objective. The aim is to reach this fixed objective at the lowest cost. The search for the most cost efficient mix of measures might seem easy at a glance, but it is a complex challenge with many interactions between multiple aims, measures and related costs. Cost effectiveness analysis can be used both to rank individual measures and programmes of measures. For measures with high costs, the estimates can be used in a further analysis of disproportionate costs, based on a cost-benefit analysis.

Based on theoretical considerations, EU-guidelines and existing analyses the purpose of this report is to describe methods for selecting the most cost effective measures under different conditions.

The report examines the methods, but does not give recommendations regarding specific measures as this is discussed in another group within this project. In this report it is assumed that the effect measures will have on losses of nutrients to the environment can be calculated, although the issue of uncertainty will also be discussed. Cost of recovery of water services is presented in the Basic analysis which has already been conducted by the counties in Denmark and is therefore not included in this report.

1.3. The content of this report

Chapter 2 provides a description of the overall use of cost effectiveness analysis in the WFD and related Danish legislation as well as the EU guidelines and WRD working groups. Chapter 3 describes the cost estimation based on the Danish guidelines issued by the Ministry of Finance (1999) and Møller et al. (2000). The differences in definitions of costs and the inclusion of side effects and how to incorporate several pollutants are discussed.

Chapter 4 provides a summary of the use of CEA in National and regional analyses in Denmark. Chapter 5 deals with some of the challenges for CEA in relation to the WFD as discussed in EU-guidelines and handbooks from EU-member states (e.g. UK, Netherlands and Germany). For each issue the Danish perspective is discussed briefly. Finally, chapter 6 provides a short discussion of the future implementation of the WFD, identifying where more effort might be needed in order to achieve a satisfactory implementation of CEA in relation to the WFD in Denmark.

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2. Cost effectiveness analysis according to the WFD

2.1. CEA in the WFD

The economic analysis related to the Water Framework Directive can be divided into three main areas as described in the introduction; the recovery of the costs of water (article 9 and annex III (a)), the selection of the most cost effective measures (annex III referring to Article 11), and an analysis of disproportional costs related to article 4 in the directive. The overview of problems and methods proposed is presented in table 1.

Table 1. Economic analyses in relation to the Water Framework Directive		
WFD	Problem	Method
Article 9	Recovery of costs of water services	Cost estimation
Article 5 and 11	Choosing cost effective measures	Cost-effectiveness
Article 4	Arguments for disproportionate costs	Cost-benefit

Source: Based on ideas in Brouwer and Strosser (2004)

Focusing on CEA analyses in relation to the Program of measures the key paragraph is listed in part b of Annex III (see box 1 below) with reference to article 11. However, there is no clear reference to the use of cost-effectiveness as a method of analysis in article 11. The WATECO interpretation is that the “economic analyses of water use stated in article 5, and the subsequent reference to annex III, also relates to annex III (b)” (Wateco, 2003). Compared to the technical specifications in the directive the description of the economic analyses is not very detailed and the reference to annex III (b) very limited. In Annex VI (part B) a general list of possible instruments (economic and administrative) to be used in order to bridge the gap between the aim and the current level is provided.

Box 1. CEA in WFD (Annex III)
<p>The economic analysis shall contain enough information in sufficient detail (taking account of the costs associated with collection of the relevant data) in order to :</p> <p>a) make the relevant calculations necessary for taking into account under article 9 the principle of recovery of the costs of water services, taking account of long term forecasts of supply and demand for water in the river basin district and where necessary:</p> <ul style="list-style-type: none">- estimates of the volume, prices and costs associated with water services, and- estimates of relevant investment including forecasts of such investments; <p>b) make judgement about the most cost-effective combination of measures in respect of water uses to be included in the programme of measures under Article 11 based on estimates of the potential costs of measures.</p>

Source: European Commission, 2000.

2.2. CEA in Danish Legislation

The Danish implementation of the WFD is made through the law of environmental aims) (Miljømålsloven) (MML). It is stated in §4 that a water plan will have to include a description of the entire program including how the targets are to be reached and the costs involved. The content of the program is described in more detail in § 25 including an economic analyses which allows for the selection of the most cost effective combination of measures. (see box 2).

Box 2. CEA in The Danish Law of Environmental Aims

The Water plan includes...

§ 4 stk. 7:

The program of measures, including the economic analysis, which has to be made in relation to this according to §25, and a summary of the program of measures, including a description of how the aims will be reached.

Program of measures

§ 25 stk.1.

The program of measures should as a minimum contain the instruments, which has to be implemented in the water district, together with guidelines on permissions and other decisions concerning the water bodies and the artificial and heavily modified water body in order to protect and improve these. The program of measures should also include an economic analysis in order to determine the most **cost effective** combination of measures.

Source: Translated from Miljømålsloven (Folketinget, 2003)

Linked to the costs of measures, §16 states that targets less stringent than good ecological status can be set if good status is impossible reach or if it would require disproportionately high costs.

Box 3. Disproportional costs in The Danish Law of Environmental Aims

Less stringent environmental objectives

§ 16. Stk. 1.

There can for certain water bodies be less stringent targets than good ecological status (surface water and ground water) if the water body is influenced by human activity as described in the basis analysis according to §6 or their natural condition is such that the achievement of these objectives would be infeasible or disproportionately expensive.

§ 17. Stk. 1.

New changes in the physical layout or changes in ground water level can justify, that less stringent targets, than good ground water conditions, good ecological status or where it is relevant good ecological potential or can justify no action to prevent deterioration of the conditions of the water body, if

- The damaging effect on the water body is reduced as much as possible
- Changes or alterations is based on important interests for the society or the benefit for the environment and the society by achieving the objectives are less than the benefit, which follows from new changes or alterations for peoples health, safety or sustainable development and
- the considerations, which are meet by the new changes or alterations of the water body, due to technical difficulties or can not be achieved using other means, which are a significantly better environmental option not entailing disproportionate costs

Source: Translated from Miljømålsloven (Folketinget, 2003)

The MML law also contains the implementation of the Habitat directive in Denmark. The timeframe for measures in relation to the Habitat directive is the same as for the WFD, but it should be noted that the economic analyses described above only refer to the WFD and that similar analyses are not required with respect to the measures related to the Habitats directive. The selection of measures which are implemented could follow the same path as in the WFD, but as only a smaller part of the country is included in the Habitat directive, exemptions due to disproportionate costs are not possible.

2.3. Procedure for cost effectiveness analysis according to the EU guidelines

In figure 1, a simple description of the overall economic analyses in the WFD is presented. Step A is the description of the river basins. The next step B is the problem identification with respect to the objective. The purpose is to identify the gap between the expected water quality in 2015 and the objective of Good ecological status. In order to close the gap measures will have to be introduced and a catalogue of measures prepared. In Step C the most cost efficient measures are selected and the issue of disproportionate costs and derogation is analysed.

Figure 1. Schedule for the economic analyses and the place of the cost effectiveness analysis

Objective	Step	Time schedule
Step A: Characterising river basins	Economic description of river basins Current level of cost recovery	Before 2004
Step B: Identification of water management issues	Problem identification to achieve the objective (GAP-analysis) ↓ Problem No problem ↓ ↓ Supplementary measures No additional measures	
Step C: Identification of cost-effective package of measures	Cost-effective Analysis ↓ Disproportionate costs? ↓ Derogation Determine total costs	

Source : (Wateco, 2003 and MVW, 2005)

The WATECO guidance document on the economic analyses for the WFD, describes the CEA analysis in more detail (see box 4). In the WATECO guidance document, a four step procedure is described including some areas that warrant particular attention:

Box 4. CEA procedure according to WATECO	
Step 1:	Evaluating the costs and the effectiveness of potential measures <ul style="list-style-type: none"> - Identify potential measures including basic and supplementary measures - Estimate costs of each measure - Estimate the environmental impact of each measure (effectiveness)
Look out:	<i>Potential interactions between measures (use basic measures)</i>
Step 2:	Constructing a cost effective programme of measures <ul style="list-style-type: none"> - Assess and rank cost-effectiveness of measures - Select the most cost effective programme of measures that can reach the environmental objectives - Calculate range for the total discounted costs of this programme
Look out:	<i>Uncertainty on costs and time lagged effects of measures need to be considered</i>
Step 3:	Evaluating whether costs are disproportionate <ul style="list-style-type: none"> - If total costs are proportionate go to step 4 - If total costs of the proposed programme are judged to be disproportionate estimate whether a derogation is needed on the basis of : <ul style="list-style-type: none"> a) Compare total costs to financial resources. If costs can be reduced or better managed over longer time horizon propose time derogation b) Assess total costs and benefits and propose less stringent environmental objectives. Redefine programme and make a new calculation of costs
Look out:	<i>Estimation of the need for derogation will be resource intensive</i>
Step 4:	Assessing the financial implications of programme of measures <ul style="list-style-type: none"> - Assess socio economic and distributional impact of the selected programme - Assess financial and budgetary implications of the selected programme - Identify accompanying measures - Assess potential impact on cost-recovery and incentive pricing

Source : Wateco (2003).

As also discussed in the Dutch Handbook the descriptions of the role of CEA in the WFD, sometimes allows for several interpretations on the exact analysis which has to be preformed (MVW, 2005). The Dutch find that it is not always clear which requirements are included in the analysis due to the absence of clear references. This stresses the need for more guidelines with respect to CEA both at the EU and national level.

2.4. Work on the interpretation of CEA in WFD groups

The implementation of the WFD is carried out under the Common Implementation Strategy (CIS). Under this strategy several working groups have been formed to deal with specific elements of the implementation strategy. The WATECO group was re-

lated to the Working Group on Integrated River Basin Management (2B). Following the WATECO group other groups with respect to economic analysis were formed.

The first group (ECO1) aimed to improve the integration of economics with other disciplines for the implementation of the WFD. In their report they focused on the Costs for Water Services (art. 9) and the cost for water users at the River Basin level (art. 5.) (CIS, 2004a+b). Some had hoped that they would give more attention to the issue of the selection of measures than they did (Interwies, et al., 2004).

The second group (ECO2) aimed to prove support on the issues of environmental and resource costs (Brouwer, et al., 2004; Ecologic, 2003). The objective of the ECO2 group was to clarify the concept of environmental and resource costs and their use in the context of the implementation of the WFD (Brouwer and Strosser, 2004). In the work carried out by the ECO2 group the focus was on costs defined as the benefits lost from not having the optimal use of water. In their flow chart, equivalent to box 2.4., additional measures follow after an economic evaluation of the damage (see appendix 3) (Brouwer and Strosser, 2004).

Although there have been descriptions of some of the challenges with respect to CEA analyses for selected member states in the overview of European practices this was not addressed in much detail by the ECO2-group (Brouwer and Strosser, 2004). Also, there was no clear description of how the financial or the economic costs should be calculated as the focus was on the environmental and resource costs.

The Water Directors reached the same conclusion in 2004 and decided to form a new group to look specifically at the cost effectiveness analysis. This group was formed in June 2004 and their report was presented to the Water Directors in June 2006. This CIS report is based on input from member states and Pilot River Basins and the findings are included in the analysis in chapter 5. More member states had hoped that the commission in this group would have presented their outline for the River Basin analysis. Instead the case studies from selected member states was a very important part of their work. This group and the national reports also reflect that, in relation to WFD, there is a more urgent need to describe the required CEA analysis rather than e.g. Cost-benefit analyses as they follow after the CEA analysis.

The Netherlands and France, together with the Commission, have been active in these economic sub-groups. A number of other countries have also participated in the economic sub-groups, but Denmark has until now not been actively involved. However,

in relation to the cost effectiveness group, The Pilot River Project in County Funen have presented their findings and described the path they intend to follow with respect to CEA analysis.

In the United Kingdom (UK) a Collaborative Research Programme on River Basin Management Planning has been set up to develop the methodologies and to provide guidelines for these methodologies for the national and local authorities. The research programme consists of six major projects involving 14 stakeholders. In other countries the work so far has been more limited.

2.5. Definition of costs in the WFD guidelines

There are some general descriptions of the actual cost estimations in the WATECO guidance document. In the ECO2 report, the issue of cost definitions is pursued further and they refer to three types of costs:

- Resource costs
- Environmental costs
- Environmental protection costs (financial costs)

Resource costs

Resource costs are defined as “the costs of the foregone opportunities which other uses suffer due to the depletion of the resource beyond its natural rate of recharge or recovery (e.g. linked to the over-abstraction of water)” (Brouwer et al., 2004). In the ECO2 document, these costs are not limited only to water resource depletion. It is an opportunity cost of using water as a scarce resource in a particular way (e.g. through abstraction or wastewater discharge) in time and space. Resource costs only arise if alternative water uses generate higher economic value than the present or foreseen future water use (Brouwer et al., 2004). Resource costs are, in other words, the costs of an economically inefficient allocation of water use.

Environmental costs

In the WATECO guidance document, environmental costs are defined “as representing the costs of damage that water uses impose on the environment (e.g. a reduction in the ecological quality of aquatic ecosystems or the salination and degradation of productive soils)” (Brouwer et. al., 2004). One example could be the use of ground water and the damage which this causes in terms of lower water levels and fewer fish, higher emissions of pollutants or salinity problems (Brouwer et al., 2004). Environ-

mental costs can be divided into the damage to the water environment and the damage to those who use the water environment.

Environmental protection costs

The ECO2 group notes that “the actual costs and expenditures of measures, which primarily aim to protect the environment, including the water environment, are often referred to in other analyses as the environmental costs or environmental expenditures. They then go on to say that “in the WATECO guidance document these costs are referred to as “financial costs”.

Another issue in the ECO2 document is the distinction between internal or external environmental resource costs. The internal costs are production costs related to existing legislation, whereas the external costs are related to further measures also required by other stakeholders e.g. down stream. (Brower et al., 2004).

The ECO2 group presents both a cost approach and a benefit approach, which they find to be non-exclusive. The discussion in the ECO2 paper is more focused on the loss of benefits rather than on the cost estimation. In their flow diagram (see appendix 3), they require economic evaluation of the damage before going on to looking at additional measures. At the same time, they point out that if the targets are fixed then monetary values related to benefits are pointless. It is further concluded that the costs of existing measures will be a part of the total costs related to the implementation of the WFD.

Based on the above definitions it seems that most of the effort so far has been devoted to discussions regarding loss of benefit from in-optimal water allocation and not so much on the direct costs for different sectors to achieve the targets. This might be because the focus is on including all costs when looking at recovery of costs for water in article 9. Some would argue that the issue of recovery of costs, dealing with the distribution of water is separate from the issue of water quality.

The focus in this report is therefore on the direct costs. However, it is surprisingly that the ECO2 group (also Brouwer, 2006) does not describe or discuss the direct costs more as this is the key issue in the National guidelines on cost effectiveness from several member states. As discussed in chapter 5 estimating the direct costs is not always straight forward.

2.6. Effectiveness

In the economic analysis it is assumed that the effectiveness of the selected measures can be calculated although it might often be a complex analysis. The Danish analysis has often focused on Nitrogen leaching, but to include Phosphorus and - at the same time – a shift from looking at the leaching to the loss to water bodies will make the analysis more complex. There will be larger variation in effects that found in previous analyses.

It is important that the costs calculated above relate to exactly the same measure for which the effectiveness analysis is carried out. Differences in assumptions can change the cost effectiveness significantly.

As discussed with respect to costs over time, the effectiveness over time might also be considered. The basic approach is that the effectiveness of a given measure is reached before the deadline, which in this case is 2015. In the CEA analysis, the focus is not on whether the goal is reached tomorrow or just before the deadline.

As the time from implementation to effect can be more than 10 years it is relevant to discuss whether an improvement in the quality of surface water has the same value to the society if it happens in 2010 or in 2027? It is clearly better to have the improvement in the water quality today rather than later, but including this aspect is not without problems. In the recommendations proposed by Møller et al. (2000), it is stated that care has to be taken when discounting the environmental effect.

The recommendation with respect to CEA is therefore not to discount the environmental benefits, but instead to describe when the improvement of e.g. the surface water will take place based on a given package of measures.

2.7. Cost effectiveness and the ranking of measures

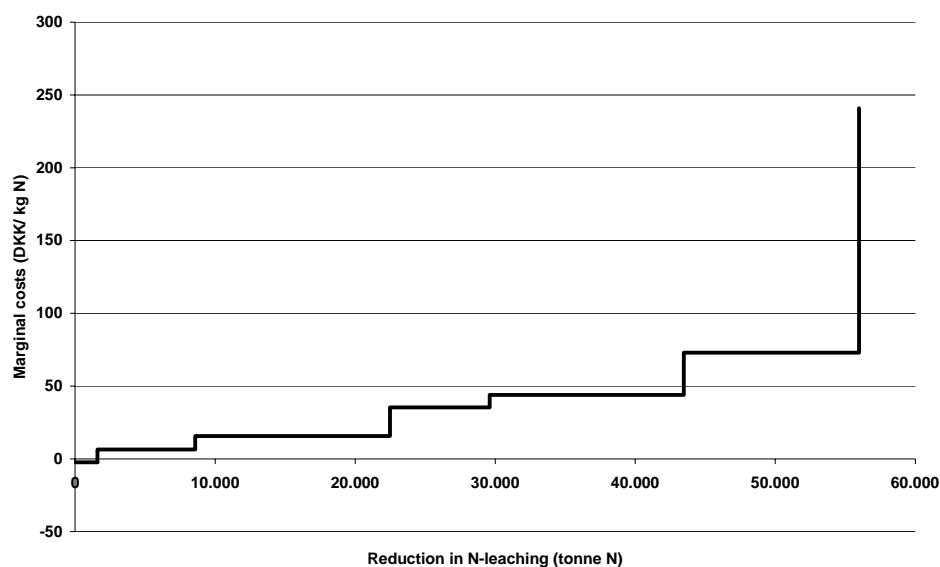
The cost effectiveness of a given measure is calculated as the annual costs divided by the annual effectiveness. In cases where NPV is used the total effect on the environment over the lifespan of the project has to be used to reach the correct ranking of measures.

With a range of measures aimed at one target, the ranking is straightforward as the measure with the lowest cost per annual effect is ranked the highest. This procedure leads to a step diagram where each measure is one step. The diagram will show in-

creasing marginal costs with improvement in the environment (se figure 3.1.) (see e.g. Møller et al., 2000 and others). Instead of the improvement in e.g. tonnes on the x-axis the degree to which the objective has been fulfilled is sometimes used.

It is assumed that each measure has the same costs for the interval analysed. In the case of increasing costs with increased implementation, the estimate can be divided into several sub measures where the related costs can be determined. In this case, one measure will be split into several “steps” on the cost-effectiveness ladder (Jacobsen et al., 2004). It is likely that some cost functions will be rather flat, whereas some might be very steep towards the end of the interval for which the estimation is made.

Figure 2. An example of the Cost effectiveness ladder based on costs of reducing N-leaching



Source: Own preparation based on plan for the Aquatic Environment III

In case the measure has an effect on several nutrients aimed at the same objective (e.g. reduction in eutrophication) it is recommend to weigh these effects together and measure them in e.g. N-equivalents or eutrophication equivalents (Jacobsen et al., 2004 and MVW, 2005). In order to do this, the effects on both N- and P-losses need to be calculated and a trade-off between N- and P-losses to e.g. the river or fjord

needs to be determined (Jacobsen et al., 2004, NIRAS and Carl Bro, 2004). This can in some cases prove to be difficult.

In case this trade off has not been calculated the recommendation from the environmental Agency has been to assume a 1:1 relationship where a reduction of 1 kg N is equivalent to a reduction of 1 kg P. In this case, the costs per percent in relation to the objective can be used (NIRAS and Carl Bro, 2004).

With analyses indicating that the P:N-ratio is well above 10, the assumption that the ratio is 1:1 will make measures aimed at reducing P-losses less cost efficient in comparison with measures aimed at reducing N-losses. A new recommendation regarding the N:P effect will have to be issued once knowledge regarding P losses increases.

The ranking is more complex when measures has an effect on several types of nutrients, aimed at several water bodies (rivers, lakes and fjords) and with down stream interrelations on the water systems as well as with inter dependency between measures. On top of that comes the objectives which are non quantifiable (e.g. biodiversity), which nevertheless have to be addressed in the measures proposed.

The ideal solution would be to use linear or non-linear programming to solve this problem and find the optimal solution. It can be difficult to include interactions between different measures, but examples are present of successful analysis using LP-programming in order to find the most cost effective measures (Nygaard-Pedersen, 2007 and Nygaard-Pedersen and Jacobsen, 2007). Also the importance of a transparent approach in relation to stakeholder participation has to be taken into consideration.

The general recommendation at present is to start with a step-by-step approach, where the focus is on one type of water body (e.g. groundwater) and the main type of nutrient lost to this type of water body (see section 4.2.). It is here possible to analyse the effect of measures one-by-one including the interrelation between measures. The next step is then to look at the next water body e.g. streams or lakes and finish with the impact on the fjords. The analysis regarding the fjords will then include the effects of measures directed at other water bodies before the strictly fjord related measures are analysed.

In this process it might be necessary to lump dependent measures together in packages of measures. The search for the optimal solution can prove to be difficult, but the

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second best solution e.g. based on simulations, etc. can in many ways be acceptable especially in the preparation of the first water plans. Over time the choice of measures, evaluation of effectiveness, etc. will gradually become better. The issue is further addressed in chapter 5.

3. Cost efficiency analysis in Denmark

This chapter deals with the different cost definitions used in the Danish guidelines on economic assessment of environmental projects and WFD guidelines. The description includes some discussion of cost efficiency ranking procedures.

3.1. Introduction

The costs related to a given measure include investments and running costs, as well as the income from the implementation of a given measure. In other words, it includes the net loss of present income and the net income for any new activity. The definition of costs used in Danish WFD projects follows the guidelines written by the Ministry of Finance (1999) and Møller et al. (2000), which also describe the basic ideas behind the welfare economic principles.

A more general overview of cost categories and the environmental consequences is presented in Table 2. The costs include the different costs associated with a change in production, etc. The changes are compared to the present situation or the baseline and so the change in profit from present activities (base line) is included in the cost calculation. In the case of agricultural measures, the indirect costs include loss of income for companies providing services for the farmer (e.g. fertiliser company), but also companies, which process and sell the products (e.g. dairy). In some analyses, the effect on employment is calculated although the actual effect might be that people change jobs and not that they become unemployed. As terminology with respect to accounting varies between different countries a short description of the terminologies used in the Danish Account statistics is presented in Appendix 1.

Tabel 2. Overview of costs and environmental consequences included in the analysis		
Type of consequences	Economic consequences	Environmental consequences
Direct consequence	Investments Running costs (e.g. maintenance) Income Change in income and cost on present activity	The direct environmental effects are not valued in the analyses as as it is these that the costs are measured against.
Indirect consequences	Change in income in related companies Change in employment	Value of side effects

Source: Based on Møller et al. (2000) and COWI (2006)

The direct environmental change is not valued as this is the effect of a given measure. The value of side effects or additional effects can be included in the analysis. Often the term **costs** refers to the direct costs (cost minus income changes), whereas the term **net costs** has been used to refer to an analysis in which e.g. the value of side effects is deducted (Watervision, 2005).

Calculating the costs of a project can be done by calculating the net present value (NPV) and using discounting to take into account the time aspect of costs and income. The overall principle is that if the NPV is positive the project is profitable. When choosing between different projects, care has to be taken so that projects evaluated on the basis of NPV are based on the same time span. It is therefore recommended to calculate the costs as an annual value. This will ease the ranking of the projects as values can be compared directly (Møller et al., 2000 and others).

In most cases the annual cost is also preferred as this is easier to communicate, whereas a very large NPV is more difficult for decision makers to relate to (Jacobsen, 1989). The annual value is used in most national CEA and is also recommended in the Dutch handbook (MVW, 2005).

3.2. Budgetary and welfare costs

The budgetary costs are the direct costs as seen e.g. by the farmer or the government, whereas the welfare economic calculation is based on a utility approach at the national scale. This implies that income transfers e.g. from the state to farmers are not included as they are internal transferrings (Møller et al., 2000).

Income received from the EU (e.g. single payment to farmers) is an income when looking at the analysis from a national perspective, but when using an EU perspective it becomes an internal transfer, which should not be included in the calculation. Although the approach used follow the overall welfare economic principles, no other countries in Europe use the same principles for the estimation of welfare economic costs although the aim seems to be the same.

The budgetary cost approach is very useful when an overview of who is paying how much for a given package of measure is required (e.g. Jacobsen, 2004). It is therefore the costs that decisions makers need to assess the changes in their budgets.

The formula for cost estimation for a given measure is:

$$AMC_b = (I * \alpha_{n,i}^{-1} + RC + E - SC)$$

$$AMC_w = (I * \alpha_{n,j}^{-1} + RC + E - SC) * NLF * TAX - AB$$

Where:

AMC_b	Annual marginal cost based on a budget economic calculation
AMC_w	Annual marginal cost based on a welfare economic calculation
I	Investment
$\alpha_{n,i}$	Annuity factor (n= years, i = budget economic interest)
$\alpha_{n,j}$	Annuity factor (n= years, j = welfare economic interest)
RC	Recurring costs (variable and fixed costs) (e.g. fertilizer, maintenance, energy, taxes)
E	Reduction in earnings
SC	Saved costs or income gains
NLF	Net levy factor (Standard used: 1.17 for domestic products or 1.25 for international products)
TAX	Tax distortion effect (Standard used: 1.2)
AB	Net value of additional benefits

Note: Wider economic impacts and administrative costs are not included

$\alpha_{n,j}^{-1}$ is known as the **amortisation factor**

Often the welfare economic cost calculation will be based on an estimation of the direct costs and then adjusted according to the principles described below. The difference between the two cost estimates relate mainly to the following issues (Møller et al., 2000 and others) which will be discussed briefly below:

- Time preference
- Prices and transfers
- Tax effect
- Side effects (indirect or additional effects)
- Wider economic impact
- Administrative costs

3.3. Time preference

When calculating the costs of projects, the cost of money over time has to be accounted for. The rate of interest is based on the alternative use of capital and so it is often the alternative interest minus inflation (real interest) from e.g. bonds, which is used as the alternative interest level. In a perfect market, the marginal yield from capital, the consumers' time preference rate and the interest will be the same (Ministry of Finance, 1999).

The Ministry of Finance (1999) recommends that both the budgetary and the welfare economic interest rate used in these calculations are 6% (real interest rate). A real interest rate of 6% in budgetary analyses means that the calculated costs are higher than the actual interest payment in recent years where the real interest has been under 2%.

According to Møller et al., (2000) the alternative interest rate used for the investment calculation for a given project should be 3%. In the welfare economic analysis, the time preference based interest should be used. It can be difficult to establish the alternative yield according to the welfare economic principles. The alternative rate of return from investments, which companies make, is used as an indicator for the yield that society is expected to receive. This rate is estimated at 6% which is also used in budgetary analysis (Møller et al., 2000).

To account for the alternative yields which can be obtained for investments based on welfare economic principles (Møller et al., 2000 and later adjusted in Møller, 2001) it is suggested that the annuity factor is multiplied by the rate of return factor ff_k , where

$$ff_k = q / r * (1 - (1 / (1+r))^T) + (1 / (1+r))^T$$

q = the alternative yield rate which is the alternative return on capital (recommendation is 6 pct.)

r = interest rate (recommendation is 3 pct.)

T = time horizon for the entire project

The rate of return factor is the net present value of the alternative yield over the period T. This factor is multiplied with the part of the investment which would not have been used for consumption (Møller et al., 2000). In some cases the yield rate (q) is only used for public spending where the alternative is other public investments (COWI, 2006).

So one method is based on the recommendation made by the Environmental Agency (3 pct. interest and using a alternative yield rate of 6 pct.) whereas the Ministry of Finance recommend the use of 6 pct. in all project appraisals. The two different concepts can be described like this:

$$AMC_{wF} = I * \alpha_{n,j}^{-1}$$

$$AMC_{wM} = I * ff_k * \alpha_{n,k}^{-1}$$

I	Investment
ff_k	Rate of return factor
$\alpha_{n,k}$	Annuity factor (n= years, k = interest = 3%)
$\alpha_{n,j}$	Annuity factor (n= years, j = interest = 6%)

It is suggested by the Ministry of finance that an interest rate of 6 pct. be used in all WFD evaluations. For projects lasting less than 50 years, the difference is no more than 10 pct. with the current levels of interest (COWI, 2006). It is generally recommended that a sensitivity analysis using an interest of 3 pct. should be performed.

This interest rate has been based on financial yields until the year 2000. However, the Danish interest rates have been low in recent years, but the alternative yield based on shares has been fairly high. Other analyses carried out in e.g. Norway, UK and the recommendations used with respect to “impact assessment” in the EU seem to indicate that an alternative yield of 4 pct. should be used. This would suggest that a re-evaluation of alternative yield for public investments used in economic analysis in Denmark might be needed.

The pragmatic approach until then is to follow the Ministry of Finance’s recommendation and use an interest of 6% and to include a sensitivity analysis using 3% for both budgetary and welfare economic analyses.

3.4. Prices and transfers

In the welfare economic analysis, the prices used should reflect consumers’ willingness to buy these goods. As most investments and costs data are without VAT, they are not comparable with the preferences which consumers might have for these goods. This is why the factor prices are multiplied by the net levy factor. (Møller et al., 2000)

The net levy factor is aimed at translating the factor costs into consumer costs, taking account of the levy which is imposed. The net levy factor is therefore another way of expressing the average levy on goods in Denmark. The net levy factor is set at 1.17 for domestic products and 1.25 for products which are traded internationally (Møller et al., 2000).

The interest payments, taxes and levies are not included in the welfare economic calculation. As the analysis is carried out based on a national perspective subsidies from the EU are included as income (e.g. single farm payment scheme), whereas national subsidies which involve a transfer of income from one sector to another are not included (Møller et al., 2000). The effect on the land rent calculation is described in Schou and Abildtrup (2005) (see also appendix 1).

3.5. Tax effect

Distortions in relation to the tax effect might be important when the measures involve public investments. A general rule is that, a tax distortion will occur in cases where measures are financed based on an increase in taxes. Also, some additional administrative costs in relation to the taxation might be encountered.

This loss in consumer surplus is estimated to be 20 pct. (Ministry of Finance, 1999). To account for this, the costs of measures, which are based on public finance, will have to be multiplied by 1.2.

For measures financed in other ways, the level of tax distortion will have to be calculated separately. It can be argued that the tax effect does not include measures financed through user payment. The general recommendation is to use a level of 20 pct. on all measures, but most analyses at the River basin level does not include the tax effect.

3.6. Side effects

The measures will be aimed at reaching the environmental objective e.g. good ecological status for rivers. However, measures will often have additional or side effects which improve the environment and which benefit society. This benefit is not included in the cost calculations in so far as there is often no market for these effects. It should be noted that the side effects can be both positive and negative.

For example, the side effects related to agricultural measures can be:

- Reduction in GHG (Green House Gas) emissions
- Reduction in ammonia emissions
- Reductions in odour from animal production
- Increased biodiversity
- Increased recreational benefits
- Increased possibilities for fishing and hunting

In general, it is difficult to calculate all the side effects of a given measure, while some will just be described qualitatively. For the ranking of measures to be uniform, data concerning a given side effect has to be calculated for all measures.

The value of these benefits can be determined in many ways, but in analyses where the focus is on cost-efficiency, the shadow cost principle can be used. The basic idea is that if there is a national target for e.g. ammonia emissions some measures will have to be implemented to reach this target. The cost of previous measures, or likely alternative measures, then constitutes the alternative cost which could be used.

In some cases, the choice of which side effects are included in the calculation can influence the ranking. The recommendation with respect to side effects in CEA, is to only include the side effect where the impact is calculated for all measures and to present the ranking of measures with and without side effects.

3.7. Wider economic effects

Wider economic effects include the effect that given measures have on the related production as a secondary effect. A reduction in pig production in a given area would imply lower economic activity among people providing services and products to these farms and for those who buy their products from these farms. The changes can be calculated based on input-output tables on the agricultural activity. The national input-output tables are divided into a more detailed description of the interaction between different parts of the primary sector and secondary sector (backward and upward effects) (Jacobsen, 1996).

In order to allow for effects on prices and income a general equilibrium model can be used, but in most cases the approach based on input-output tables is recommended. The wider economic implications are only included when the change is significant to a given region. The effect on employment can be divided into effects in the short and

long run, as it is assumed that people typically will be able to find other jobs in the long run, but perhaps not in the short run.

3.8. Administrative costs

Administrative costs have only recently been included in economic analyses in Denmark (e.g. Jacobsen et al., 2004, Schou, 2003). The administrative costs normally include both additional costs for the farmer and his advisors as well as public administrative costs at the local and national level.

The time spent on the administrative aspects of a specific task can be difficult to estimate and will in many cases be based on interviews with the people carrying out the tasks. In other cases it is easier to estimate total administrative costs, such as those involved with fertiliser control, as the total cost is equal to the running cost of the people responsible for this task.

In relation to the payment of subsidies, the administrative costs involved in a given year can be difficult to estimate as the administrative costs might be the same every year, but the subsidy paid to increase the area with trees, etc. might vary a lot from year to year. It is recommended to relate the administrative costs for a given measure to the total public spending in that year. Often the administrative costs related to e.g. wetland projects are highest at the beginning of the project. Analysis of the administrative costs related to different measures in relation to the aquatic environment can be found in Jacobsen et al. (2004).

It is not recommended to include administrative costs in the first regional analyses of different measures, but some overall estimates might be useful.

4. CEA methods used in National and Regional Plans

This section deals with the experiences of using CEA in empirical analyses at the national and regional level in Denmark. The aim is to look at the experiences with respect to methods, measures and calculations of cost effectiveness. The measures are aimed at reducing eutrophication and especially Nitrogen losses. It is hoped that these empirical analyses will provide some insight into the challenges of actually carrying out cost effectiveness analysis at the River Basin level. The current analyses at the River Basin level are funded by the local counties, but no pilot projects on economic analyses have been instigated at the national level until now. It was the intention to include more detailed CEA from other EU-countries, but this has not been possible within the given time frame.

4.1. CEA in National analyses

The high loads of nitrogen (N) in the mid 1980's led to the Plan for the Aquatic Environment I (Action Plan I) which aimed at reducing N-leaching by 50%. After additional legislation and further plans such as the Action Plan II in 1998, the aim was achieved in 2003 (NERI and DIAS, 2004). In order to further reduce N-leaching by 13% and to reduce the phosphorus (P) surplus by 50%, Action Plan III was implemented in 2005 (SNS and FVM, 2004). This plan can be seen as the first step towards fulfilling the aims of the WFD in Denmark. The time frame is the same, as the goals in Action Plan III have to be achieved in 2015. However, it is expected that further measures will be required to fulfil the WFD.

The focus of Action Plan I was a reduction in both diffuse and point source pollution, whereas the focus of Action Plan II and III was the reduction of diffuse pollution from agriculture. With these Action Plans which have primarily focused on the reduction of nitrogen leaching, Denmark has a lot of experience in assessing the effectiveness of measures and monitoring water quality. In the Action Plans II and III midterm evaluations have been introduced to monitor progress. This has been helpful in establishing realistic estimates of the effects of different measures both individually and combined.

The lesson learnt is that it takes longer than expected to achieve the expected improvements in N-leaching (e.g. Jacobsen et al., 2004). When the effect is measured in the surface water it will take even longer before the effects can be detected. In some ways, a target of 2015 might seem far away, but taking the hydrology conditions into

account it is not so far away. It is expected that the majority of streams, lakes and fjords will not achieve the WFD objectives by 2015 (EPA, 2006). With the time lag experienced in previous action plans reaching stringent targets in Denmark by 2015 based on plans implemented in 2009-2010 will be a major challenge.

Most of the economic analyses related to the cost of measures, prior to Action Plan III, were carried out at the National level. These analyses were mainly focused on the direct costs for the government and the agricultural sector of implementing national regulation (e.g. Jacobsen, 2004 and Jacobsen et al., 2005). With the Action Plan III, the need for regional analyses was reflected in the case studies included in the review of measures. Here the costs were measured as the costs related to the change in N and P-losses to the recipient which will also be the case in relation to the WFD (Jacobsen et al., 2004) (see also www.vmp3.dk).

The evaluation of the Action Plan II focused on effectiveness, but initiatives were taken by the Institute of Food and Resource Economics (FOI) to carry out a economic midterm and final evaluation of the direct costs. This helps to give a better estimate of the actual costs of the measures employed. It also helps to avoid the problem of over estimating the costs when they are based solely on cost estimates from the sector itself or when the rate of innovation has been underestimated (as discussed in RPA, 2004). Another issue has been the changes in cost related to how the administrative implementation has been carried out. As an example the Action Plan I included green crops (catch crops), but during the administrative implementation the use of winter wheat as green winter crops was permitted. As winter wheat was more profitable this requirement did in fact not cost the sector as much as anticipated.

With respect to the calculation prior to Action Plan II, cost-effectiveness ratios were included for each potential measure in relation to N-leaching. The final package of measures can be seen as being a mix of cost effective measures and measures which had other benefits which were in line with political interests. The costs in focus were the direct costs for the government and the costs for farmers.

With Action Plan III, the cost-effectiveness calculations were extended to cover welfare economic costs and side effects, as well as the administrative costs. In some analyses the employment effects were also calculated. Some preliminary estimates on cost-effectiveness in relation to P were also produced, but the effectiveness of these measures was still very uncertain. In other words, a broader cost analysis of the individual measures was employed in Action Plan III than in previous estimates

(Jacobsen et al., 2004). The economic calculations prior to Action Plan III included a choice of instruments (administrative or economic instruments), as well as analyses at both national and regional level. The lesson was that the inclusion of wider and more complex analyses requires more cooperation and is more resource demanding.

The economic analyses of the costs of the implementation of the WFD in Denmark have been under way for some time, but the uncertainty of the targets has delayed the process. Some preliminary targets and measures have been proposed at the national level and a first preliminary estimate of the total costs were calculated in 2004 (NERI, 2004). The estimated cost shows a large interval due to the uncertainty related to the target and the measures required. However, the calculation did imply that a strict implementation of the WFD might be costly.

4.2. CEA at the River Basin level

4.2.1. Odense Fjord

As a EU pilot river basin, the River Basin of Odense Fjord has been involved in the implementation of the WFD for a number of years. The water section of the county authorities has been active in other projects and discussions regarding future water quality dating back from the first action plan and the data is therefore better than average in Denmark.

As with many river Basins in Denmark, nutrient losses to the Odense Fjord River Basin will have to be reduced in order to achieve the expected WFD objectives. The analyses according to Art. 5 were finished in 2003 (Funen County, 2003).

In order to achieve the target the following has to take place

- Reduction in P-losses to lakes, as few lakes meet the expected targets
- Reductions in N-losses to streams and the fjord
- Reductions in N-losses to preserve groundwater

The targets were expressed in tonnes of N lost to the fjord and the cost effectiveness of the measures was only calculated with respect to N. Reducing P-losses has been discussed, but it has so far been too difficult to estimate the effectiveness of different measures.

The economic analyses in the Odense River Basin have been divided into two phases.

Phase I:

Looking at measures and costs required to meet the target for each type of water body (streams, lakes, fjord and groundwater). A selection of measures was made to fulfil the aims of each water body separately. No attempts were made to combine the measures, but it was expected that the overall costs would be lower when the combined analyses were carried out in the second phase. The phase was conducted by the county in 2005 (Funen County, 2005).

Phase II:

In the second phase each area (sub basin) and lakes, etc. were analysed. The available area for each measure (wetland, forestry, etc.) in each sub basin was determined. The costs were calculated according to the principles in chapter 3.1, but administrative costs and the tax effect were not included as the implementation of the measures was still unknown. The final report prepared by the COWI consultancy group was presented at the end of 2006. (Funen County, 2006 and COWI, 2006). A new report from the environmental centre in Odense gives a summary of the results (Miljøcenter Odense, 2007).

Based on the total catalogue of around 40 measures covering both some measures were decided as “must” measures before the CEA. These “must” measures focus on point source pollution and the physical restoration of watercourses. The mix of these measures was decided by Funen County.

The ranking of the other measures has been based on cost-effectiveness where the cost per kg N lost was estimated using conditional ranking. The CEA, with respect to reducing N-losses, ended up being a step-by-step procedure in order to deal with the up-stream issue (see also 4.2.3.). The phases were:

1. The first phase was to introduce cost effective measures in order to reduce N-losses to ground water for each sub basin. The effect on other recipients (the Fjord and four lakes) was calculated
2. Then the most cost effective combination of measures for four lakes which have an influence on other lakes was analysed. Based on individual cost effectiveness studies, the optimal mix of measures was decided and the effect on other lakes down stream was calculated

3. Then the cost effective combination for the remaining 7 lakes in the analysis was found and the effect on the Fjord was calculated
4. Finally, the most cost effective combination of measures related to the Fjord was decided

As a follow up procedure, the cost estimates for the different measures across the water bodies were compared and the area adjusted based on the marginal cost of reduction for all measures.

The findings from the project suggest that using the right scale in relation to the effectiveness of measures is a challenge. Too much detail gives many calculations, whereas one N-retention coefficient for the whole River Basin does not give enough detail for actual implementation of measures and therefore a larger uncertainty on the effectiveness.

Additional effects have not been included so far due to the risk that the inclusion of some additional effects, which can be measured, as opposed to some additional measures which can not be measured, might change the cost-effectiveness ranking. It was decided not to include the additional effects in the cost effectiveness ranking.

The final report shows that a large part of the measures and the costs are related to point source pollution. Some of these measures are related to other requirements than the WFD, but the measures required to achieve the WFD is significant. This suggests that point source pollution and the protection of groundwater has to be included in the analysis. The most cost-effective measures are higher utilisation of animal manure, catch crops and set a side.

The analysis gives some ideas of the financial burden for the different stakeholders and municipalities. The costs and the overall effect on N-losses is here broken down to the municipality level, although this is also not easy as some measures implemented in one municipality can greatly affect the required measures and the costs in another municipality.

With respect to disproportionate costs, the analyses carried out will not provide a sufficient foundation for an analysis of the disproportionate costs on their own. It is difficult to link the costs specifically to the target in one particular water body as the measures interact. Another point is that although the analyses cover 12 lakes and

some streams they do not cover all of the 2000 lakes and 300 streams in the Odense River Basin. Procedures have to be developed on how to progress from the few well known water bodies to all water bodies. It seems likely that the first plans will only cover the larger lakes and streams.

Using Linear Programming allows interactions between measures as well as up- and down-stream effects to be included simultaneously to reach multiple reduction targets (nitrogen and phosphorus) in multiple sub-basins (Nygaard-Pedersen, 2007 and Nygaard-Pedersen and Jacobsen, 2007). LP-programming can be a valuable tool when the targets can be expressed in terms of N and P reductions. The results show that the Nitrogen reduction target can be reached in 9 out of 11 sub basins. With respect to reductions in P-load the suggested reductions exceed the target in several sub basins. Some is due to interactions between measures, but it is likely that the effect of wetlands on the P reduction is overestimated although a cautious approach has been adopted. In some cases up-stream measures have been chosen in the process of reaching down-stream targets, as they are cheaper than the down stream measures. For three sub basins the P target can not be reached.

Further analyses relating to disproportionate costs will be carried out in the research project AQUAMONEY (Brouwer et al., 2005), where Odense River Basin is a case-study area. Due to limited projects funding, no new benefits will be established and the focus will be on benefit transfer. A key question here is to what extent benefits can be transferred to other areas.

4.2.2. Ringkøbing Fjord

Ringkøbing County has requested analyses of the conditions in Ringkøbing Fjord in relation to the likely objective of the WFD. Ringkøbing Fjord is a special case as the salt content in the fjord can be controlled via a lock to the sea. In recent years, the salinity level has been fairly high, which has improved the depth of vision, but there has been problems with seaweed, etc (Ringkøbing County, 2005).

Ringkøbing County has requested an analysis of the effectiveness and the costs of selected measures. The analysis has shown that the N losses to the fjord have to be reduced by more than 50% in order to meet the objectives, which is a depth of vision of 2 meters with lower salinity levels in the water (Abildtrup et al., 2004). The objective for the fjord is assumed to be close to the expected objective according to the WFD.

The main aim is to reduce N-losses from diffuse pollution (agriculture) to the fjord. The loss of P was not included due to the uncertainty in calculating the losses and the effect of given measures.

The measures included in the analysis were wetlands, reduced N-application and reduced livestock. The economic analysis included an estimation of the direct costs divided into costs for agriculture, the county, the Danish state and the EU (Abildtrup et al., 2004 and Jacobsen et al., 2006). Besides, an analysis of the costs the effect on the number of jobs lost was also included. The political process following the analysis showed that the effect on jobs lost in the agricultural sector is a key issue when decisions are made by local politicians. The costs of reducing livestock numbers were found to be too high and were therefore not included in the final plan (Ringkøbing County, 2005). Instead it was replaced by other measures, a postponement of the deadline and a small reduction in the environmental objective. According to the present plan the result will be a 40-50% reduction in N losses by 2015 (Ringkøbing County, 2005).

The hydrological analysis showed that the effect of reducing livestock was less than expected. This was partly due to the effects of the previous national action plans and the fact that the pack of measures gives a smaller effect than the sum of each measure. This shows that the interrelation between measures is important. The use of a map locating the most vulnerable N-zones was very useful for the site specific location of the measures (Abildtrup et al., 2004, Ringkøbing County, 2005).

4.2.3. Værebro Stream (Copenhagen County)

Copenhagen County wanted to develop a tool which would help them to analyse what is required to fulfil the future requirements in relation to the WFD. Watervision, in cooperation with FOI and Carl Bro, presented the results of a pilot project in 2005 where a first version of the tool was used to assess plans to reduce nutrient losses and increase the water flow in the water body of the Værebro stream (WaterVision, 2005).

Water flow is mentioned explicitly in this project because the project is situated on Zealand where shortage of groundwater might be a problem. The high use of groundwater has affected the water flow in many streams and a number of streams are therefore dry during parts of the year. As the Værebro stream is also close to built up areas, the measures are aimed at both point source and diffuse pollution. The measures to reduce point source pollution include upgrading the sewage treatment plants, upgrading the size of the public drain pipes and increased soakaways to reduce local over-

flow and the extension of public drains to all residential areas. The measures used to reduce non point pollution are directed towards agriculture.

The analyses include:

- Værebros stream and related streams (Tibberup and Jonstrup)
- Søndersø (lake)
- Parts of Roskilde Fjord

The analysis of measures was based on a step-by-step approach starting with the measures aimed at Søndersø which were introduced and calculated. These were followed by measures aimed at the streams and then finally measures aimed at reducing the losses to the fjord. Analysis estimates of the down-stream effect were required in order to calculate what effect changes in nutrient loss in one stream might have on another stream and the fjord.

The focus has been on N losses, but P is included in a fairly simplistic way. It is assumed that the eutrophication effect of P is 20 times the effect of N. This allows for the cost-efficiency to be calculated in relation to N-equivalents, as suggested in Jacobsen et al. (2004).

The cost analysis here is based on a net cost approach, where the direct costs minus some benefits are included. The benefits included reductions in CO₂ emissions, the value of groundwater and the recreational benefits of forest, wetlands and lakes, etc. The cost effectiveness ranking is based on these cost estimates. A number of the benefit estimates are based on benefit transfers with the uncertainty this implies. As the project is a pilot project, one of the purposes was to see how side effects can be included and what effect this has on the ranking. It is stressed in the analysis that better estimates can be included when they are available.

With respect to discounting, a factor of 6 % was used based on recommendations from the Danish Ministry of Finance (1999). However, it is noted that perhaps 3 % is more appropriate in a situation with low interest rates. To ensure that even those measures where the effects occur after many years are accounted for, the use of hyperbolic discounting is suggested. This would imply that the interest rate is reduced after a number of years.

The most cost-effective measures were forestry, wetlands and measures to reduce the overflow of rainwater. Wetlands would also be cost-efficient without additional ef-

fects, whereas forestry would be much less cost-efficient without the additional benefits. Although agricultural measures in general are cheaper a number of measures to reduce nutrient losses from source point sources are cost efficient.

The analysis showed that the total net cost of implementing these measures is relatively low and that a reduction of N-equivalent to 39% in Roskilde Fjord can be obtained without any net costs, when some benefits are included. The costs without the benefits are around 80 DKK per N-equivalent lost to the fjord. The objective for the lake (25 µg P/l) can not be achieved with the suggested measures and the costs for other measures would probably be rather high. This indicates that the costs would be disproportionate, but again it depends on the benefits.

Another finding is that moving the abstraction of water can increase the overall water flow and reduce the number of dry streams. For one stream the aim was to achieve an average water flow of 60 litres per second with a minimum flow of 20 litre per second. The tool here can help to locate the abstraction of water and increase the water flow.

Knowledge of the implications of abstracting water on the future water quantity and quality is essential. Programs for a better description of where the water is generated are important for plans to insure the long term water quality. Such analyses are currently underway in many water companies so that the requirements in the Ground Water directive can be met also in the future.

Another point is easy access to GIS-maps in order to find the actual location of measures. The analysis suggested a web-based GIS tool as a possible tool for the actual implementation of the WFD for both local and national authorities. The pilot project tool can be improved with more data and the spatial implementation of measures can be included in order to describe exactly where the measures will be implemented and the likely effect.

4.2.4. Mariager Fjord

Niras and Carl Bro have analysed the cost efficiency of 25 different measures to reduce nutrient losses to Mariager Fjord for Århus and North Jutland County (Niras og Carl Bro, 2004). No measures related to groundwater, lakes or streams were included.

The aim was to reduce N and P losses to the fjord by 200 and 2 tonnes respectively. The measures were mainly related to diffuse pollution, but included also measures aimed at reducing point source pollution.

The measures are ranked according to the cost effectiveness with respect to N and P separately and jointly based on the cost per percent the aim was fulfilled. It should be noted that the basic analyses is, in some cases, based on the assumption that the eutrophication effect of N and P is the same following the recommendation from the Environmental Agency.

One percent reduction in N is therefore equal to a one percent reduction in P. However, an analysis of effects indicated that a reduction of one kg P has 25 times larger than a reduction of one kg N in the fjord. The ranking of measures was therefore carried out based on N alone, P alone and a mix of N and P based on N-equivalents using both 1:1 and 1: 25 weights between N and P.

In this case the same measures were recommended as the measures ranked highest with respect to N also fulfils the P target of 2 tonnes. In other situations the ranking could have been changed according to the weights of P-reductions used in the analyses. The measures recommended include aquaculture (mussels), wetlands and a reduction in N application. There is large uncertainty related to the use of aquaculture (mussels) and the possible effects.

Some of these analyses will be continued in the NOLIMP EU project. The project is a part of EU's "Interreg IIIB North Sea programme" which focus on cooperation between regions in EU aims to provide building blocks for a CEA methodology with respect to groundwater (Niras, 2006).

5. Challenges related to the use of cost-effectiveness analysis

A preliminary report on the issue of cost effectiveness analysis in the WFD (CIS, 2006 a+b) highlights the objective of finding the most cost effective programme of measures, which can bridge the gap in water status between the baseline scenario and the objectives.

This following section deals with some key issues which previous research and empirical analyses have identified as being important. The discussions on approaches and methods is based on the WATECO guidance document compared with handbooks from Germany (Interwies et al., 2004), The Netherlands (MVW, 2005) and the United Kingdom (RPA, 2005 as well as RPA, 2003 and 2004). The chapter includes the cost-efficiency group analysis of the handbooks (CIS, 2006a). For each section the issues are discussed and related to the Danish perspective, as no Danish guidelines exist at present.

5.1. Scale of analyses (up stream – downstream)

WATECO

The WATECO document says that cost-effectiveness analysis should be preformed at the river basin scale. However, with many water bodies, the analysis could be carried out at a lower scale (more detail). The recommendation is that the cost effectiveness analysis takes place at the scale where the environmental issue occurs.

The procedure proposed in the WATECO document includes two main approaches:

A. Going from the largest to the smallest scale

Following this principle measures which cover a large area e.g. national scale should be implemented first, followed by measures which cover a part of the country, in order to finish with measures which only involve a single water body.

B. Going from the most upstream sub basin to the most downstream sub basin

This approach follows the hydrological flow. It aims at identify the measures needed to solve the environmental issues in the most up-stream basin first and then evaluating the effect of these measures downstream, before identifying the measures needed in the next sub-basin.

The two approaches are not necessarily exclusive as the measures discussed under A could be economic instruments, which can only be implemented at a national scale. The argument would be that national regulation might be cheaper to implement than local measures. In case where the country has to reduce nutrient loss significantly in the whole country, the risk of over implementation and related costs is limited. For the measures under B, the site specific location of measures is important.

Handbooks

The UK handbook recommends that an overall screening of costs and effectiveness at the national level in order to find the most cost effective measures at the national level be carried out. The next stage is to repeat the assessment at the water body level taking the national measures and adding further local measures into account. The analysis is only carried out for water bodies where problems are comparatively more difficult to solve.

The German handbook recommends that the analysis be conducted at the sub-basin level but it does not discuss this issue in greater detail.

The Dutch handbook recommends that analyses be conducted at the river-basin level as this is the level where the most cost efficient programme of measures has to be decided. However, they also discuss the up/down stream issues including the issue of sharing the costs between regions. They point out that analyses across sub-basins and countries are only needed when e.g. rivers run through several regions and where the up-stream target is the problem (e.g. lake or fjord). To compare the cost effectiveness of different measures and plans across regions the approach has to be uniform. The Dutch handbook points out that for a given river basin as a whole one region might have to pay more than others, but that region could be compensated by those that have paid less. The basic idea is that it would still be cheaper than if every region had to reach the target. With the analysis of the Rhine as an example, the present analysis is carried out with or without transfer of costs between regions. They also made a forecast of the situation in 2015 without further initiatives. For measures which both reduce emissions and affect hydromorphological issues, the costs are divided according to their effects.

The CEA group concludes “that Member states will only carry out cost effectiveness analysis in areas with significant environmental issues and where it is difficult to choose between alternative measures” (CIS, 2006a). This is in line with the basic

steps proposed by WATECO that no analyses are needed where the target has already been reached.

They go on to conclude that **“measures presented in the River Basin Management Plans by 2009 will contain measures that have not been submitted to the cost-effectiveness analysis test due to lack of data and integrated methodologies existing today”**.

The conclusion seems to be directed at the River Basins with minor environmental problems where the administrative costs of carrying out the analysis are larger than the potential benefits of improving the water quality.

However, a more serious question is whether data and a methodology is in place for an analysis of River Basins with larger environmental problems involving several targets, pressures (pollutants) and measures.

The Danish perspective

Some of the analyses carried out follow the upstream/downstream approach, but as described for the Odense River Basin it is more complex to integrate all measures directed at several targets. The partial approach adopted in the Odense River Basin study could be useful for others as a first step which is transparent for all involved.

It might be worth considering the degree of detail that should be used in the analysis in order to have plans ready by 2008. It might be that a full integrated up/down stream approach can not be carried out by 2008 for all districts. This could also involve an analysis at the sub-basin level. And extra loop could be included to ensure that measures with high costs in one sub-basin can not be replaced by a cheap measure in another sub-basin in order to reduce the overall costs at the river basin level.

Ensuring that all the relevant background data is in place and accessible in the new environmental centres and municipalities which is established in Denmark the 1st of January 2007, will be a challenge in itself. The data provided by the counties will not all be of the same layout and with the same degree of detail. It seems that many of the first case studies have been performed where much data was already in place.

Furthermore, data is not available for all lakes and streams. It is therefore logical that the effort should be directed towards the larger streams and lakes in the first round.

With respect to the scale of measures, it is likely that measures such as a tax on nitrogen (surplus or use) and a reduced nitrogen/phosphorous quota, must be implemented at the national level as this is the administrative unit for these types of measures (see Jacobsen et al., 2004). Others, e.g. area related measures may have national aims, but will be implemented at the local level with site specific reference.

At the present moment it seems that the majority of rivers, lakes and fjords do not live up to the aims of WFD. This implies that national measures can be implemented without any greater risk of over implementation for selected locations. It also implies that detailed Water plans including a CEA analysis are required for almost all of Denmark.

In order to ensure that the exchange of data between regions is possible, some guidelines will have to be produced based on experience with such plans at the national and county level.

5.2. Definitions of measures and instruments

WATECO

The WFD describes a preparation of a programme of **measures** in order to achieve the objective. One of these measures might be the use of **economic and fiscal instruments** such as a tax on nitrogen losses (see Annex VI Part B), but can also be technical measures. WATECO does not distinguish between instruments and technical measures.

Handbooks

In the UK handbook, a **measure** is defined as an action, while a **mechanism** is defined as the delivery process for implementing that action. A measure would be a reduction in the use of fertiliser and the mechanisms could be e.g. a ban on fertiliser, taxes or voluntary agreements. When a measure can be implemented through different mechanisms they should be analysed separately. The definitions used in the German handbook largely follow the WATECO definition, whereas the Dutch use of measures refer to technical interventions (change in behaviour or technical adjustment) which lead to e.g. reductions in emissions. The instruments are all activities carried out to realise this change in behaviour such as subsidies, levies and a ban, but also information, as there will be an effect once the measure is implemented. This is why the Dutch handbook on cost-effectiveness only covers the measures and not the instruments. Who is paying is dealt with in a later report. The focus is on the allocation of

measures and not the implementation. In the German handbook the application of instruments are at the EU, country and regional level, whereas measures are decided by the local authorities.

The Danish perspective

The use of measures and instruments largely follows the definitions proposed by WATECO. Measures can also be technical measures which e.g. improve the utilisation of N in animal manure. It seems likely that the measures and instruments included in the analysis will vary between countries.

In terms of definitions, the selected measure will have a bearing on the costs. Measures like a reduction in N and P discharges, as defined in the German handbook, are in some cases not precise enough to calculate the costs. In the Danish context, measures will include the steps (instruments) needed to ensure the change in behaviour either via administrative or fiscal regulation. The Danish analysis will focus on measures and the effect and the costs of implementing that specific measure (e.g. more catch crops). There will for each measure be a rather detailed description of the measure, effect, etc.

5.3. Basic or supplementary measures

Measures can be divided into **basic and supplementary** measures where the basic measures are those that are based on the **existing legislation** and the supplementary measures are additional measures mainly aimed at achieving the **WFD** objectives. More precisely, article 11 in paragraph 3 describes what the basic requirements shall consist of. In Annex VI, Part A there is a list of 11 directives including e.g. the Habitat directives. There will therefore be some measures which need to be implemented in order to fulfil present directives (e.g. the Nitrate Directive). They will be defined as basic measures although the measures and the implementation are not yet known.

The supplementary measures are described in Annex VI, Part B based on article 11, paragraph 4. WATECO stresses that it is important to assess the effectiveness of basic measures (as well as supplementary measures) and to integrate them into the cost effectiveness analysis. This is mainly due to the interactions between measures.

Handbooks

The UK guidance document does not make specific reference to **basic or supplementary** measures, but it seems to indicate that whenever a cost effectiveness analysis is

required, it should include both basic and supplementary measures. In earlier reports (RPA, 2004) it is stated that CEA covers both basic and supplementary measures, whereas CBA is only carried out for supplementary measures.

The German handbook points out that both analyses are only needed where there are significant multiple pressures, whereas the Dutch handbook indicates that the CEA analysis can also be used on the current policy. The German handbook seems to make the distinction that basic measures **must** be implemented whereas supplementary measures **may** be implemented. They do not make a clear distinction between existing and WFD legislation.

The Danish perspective

In the Danish context, it might be difficult to differentiate between basic and supplementary measures as defined in article 11. It is likely that only measures for which primary aim is to help to implement the WFD will be included in the cost effectiveness analysis and they will in this respect be supplementary measures. The implementation of e.g. the habitat and the nitrate directive is listed in Part A. The Danish Action Plan III can be seen as the first step towards implementing the WFD in Denmark, and in this case the measures included could be defined as being supplementary measures.

The analysis related to the previous plans for the aquatic environment can be used as a basis for effects and costs. When looking at disproportionate costs it might be relevant in some cases to look at the cost of basic measures in order to estimate the total costs to be used in a cost-benefit analysis.

5.4. Pre-screening of measures

WATECO

The WATECO document does not identify pre-screening as a specific step. However, it is recommended that a database of measures be developed at the EU level. The costs included would be non-site specific costs e.g. limited to financial costs.

When the pre screening of measures is included here it is because a number of guidance documents at the country level emphasise the need to pre-select measures before initiating the cost effectiveness analysis.

Handbooks

In the UK guidance document, a catalogue of 16 types of measures is described (such as reducing input, changes in price or improved management). A list of 12 mechanisms is presented to implement these (such as new technologies, taxes and subsidies). Measures which could be implemented using two different mechanisms are viewed as two different measures in the cost calculation. The pre screening activity is conducted when there are many measures. The measures eliminated prior to an in depth analysis would be the ones which rank lowest according to most effectiveness attributes. This approach might carry the risk that cost effective measures might be excluded due to errors at the beginning of the process. It is the intention that the cost data will be available in a national database.

The German Handbook identifies 17 measures (local level) and 10 instruments (e.g. national level), which will cover many of the significant problems in relation to the WFD. The handbook contains a detailed description of the measures. The German catalogue is divided into chemical (point or non-point) and hydromorphological (e.g. water abstraction, water flow and morphological changes) pressures. For each measure the following items are described: polluter category, description of measure, players involved in the implementation, an analysis of the effect, description of secondary effects, time required, geographical effect, interaction with other measures, cost estimates, and a discussion on uncertainty. The cost estimates are minimum and maximum, whereas the effects are not described in greater detail. The variation within the country is not given much attention. The German instruments include levies on e.g. mineral fertiliser, advisory approaches, but no administrative instruments. They also note that levies have to be implemented at the national level. The handbook recommends a cause and effect matrix for each water body where the effect of each measure is given a grade from no effect to high effect. The classification is then used to make a priority of measures, but how this is done is not clear. They emphasize the need to eliminate unsuited measures early on to reduce the work.

In the Dutch context, a list of measures has been prepared at the national level in a knowledge base, but it is not included in the handbook. This knowledge base contains information on the costs and the effects, but it is not currently operational. The other recommendation is that only measures relevant to the specific region should be included. The handbook focuses only on selecting of the most cost effective combinations, whereas the choice of instrument is a political decision.

The Danish perspective

A catalogue of costs and effects of different measures in order to comply with the WFD is being prepared in Denmark by The Environmental Protection Agency. Together with the newest catalogue from the Committee for long term planning of the Aquatic environment (Schou et al., 2007) and regional input from the counties this could provide the first overall catalogue of measures. It is likely that some of the cost estimates from 2005 will have to be re-estimated in light of e.g. new agricultural reforms.

Only measures where the effectiveness can be estimated can be included in a cost-effectiveness analysis, but it might be useful to have an idea of the potential measures which might be useful when the effectiveness can be estimated. Otherwise the pre-screening will probably mainly relate to regional considerations where some measures might not be relevant in some river basins or soil types, etc.

5.5. The effectiveness of an individual measure

WATECO

The guidance document indicates that different effectiveness indicators might lead to a different ranking of measures. Furthermore, some indicators might only be assessed qualitatively. In the evaluation of effectiveness, the discussion is related to the abstraction of water and the effects on biological quality and how to deal with time lags, but also how to deal with measures which serve multiple objectives.

Handbooks

The UK handbook mainly discusses issues related to effects such as: Magnitude of effect, characteristics of effects, practicality and side effects related to other environmental standards. The magnitude should be expressed in terms of the intensity of the effect (how large a reduction) and the geographical scale of the effect (e.g. over what length of river). The parameters can be expressed as a percentage of the overall gap in the environmental standards. It is noted that key qualitative attributes should be included in the description of the measure. For each measure the pressure, whether point source, diffuse, abstraction of water/flow regulation is noted before describing if the measures can remove, relocate or reduce the pressure. A detailed description of the process is found in sub-report B (RPA, 2005). Note also that the UK handbook focuses on developing combinations of measures to address each type of pressure before the cost effectiveness analysis is carried out. The proposed technique to compare combinations is well suited for 2-3 combinations, but not for choices between many

different combinations. To reduce the combinations a further screening process is suggested. The handbook discusses the issue of targets at different locations, whereas pressures related to different recipients (lakes, streams, fjords and groundwater) should be handled by grouping them in an assessment of several waterbodies.

The German handbook proposes a detailed evaluation of effectiveness based on qualitative indicators of ecological effects (scores from X to XXX). The effectiveness is not described in much detail for each measure. It seems surprising that the use of few N-loss minimizing techniques would reduce N discharges by 93% (measure 2.2). They propose that only the most effective measures be included in an assessment of the effectiveness of combinations of measures. The score of X decides the classification of priority so that the more X's the higher the effectiveness. They also propose a matrix of instruments in relation to their effects. The German handbook divides the measures into groups depending on whether the measure will have an effect well before 2015, around 2015 or after 2015. The effectiveness of combinations of measures is described as low, medium, high or very high.

In the Dutch Handbook the focus is on eutrophication as it is in Denmark, which can be prevented by reducing N and P losses. The allowed N and P losses are related to the objectives in the WFD, whereas the ecological objectives are not included in a cost-effectiveness analysis, but the effects should be described qualitatively. The effectiveness is defined as the reduction in discharges (emission reductions) to surface water. This assumes that the link between a change in behaviour and discharges to surface water can be modelled. The notion of multiple standards is also discussed. The use of eutrophication equivalents is suggested to include the effect of both N and P. Knowledge of measures and the local area is important to carry out the analysis.

A step-by-step procedure is proposed in the Dutch book in case measures have effects on various substances. The first step is to carry out a cost-effectiveness analysis for the substance which causes the most serious problem. Then the effect these measures will have on other substances is determined after which the calculation is repeated for the second most serious substance, etc.

French experiences show that building combinations of measures that reach the given level and then comparing these packages of measures might be more in line with the WFD objectives (CIS, 2006). This means that cost-effectiveness is not evaluated for each measure. On the other hand the interrelation between measures can be accounted for.

The Danish perspective

In the Danish context the objectives related to eutrophication have been translated into key indicators. In order to achieve these targets, it will be calculated by how much the N and P-losses to the waterways will have to be reduced. This has also been the key focus in the empirical analyses carried out in Denmark so far. In narrowing the focus down to two nutrients, the cost efficiency analysis is easier to perform. The use of eutrophication equivalents will be useful if the relationship between reductions in N and P losses can be established.

It will still be relevant to look at multiple aims. The effectiveness of each individual measure might affect both the N and P losses, but it might affect streams, lakes, and fjords. With respect to groundwater, other indicators have been chosen such as water quality, but also some additional targets such as water flow and ecological parameters could be included.

For each measure an anticipated change in behaviour will be calculated. This will include both direct effects, but also implicit effects. As an example, the introduction of N-norms at the farm level has meant that the N is distributed to the fields which generate the highest income per kg N. Furthermore, the use of standard figures for nutrient content in animal manure gives an indirect encouragement to reduce N-losses in stables and storage. Such changes in the behavioural response might be important both when estimating costs and effectiveness.

The effectiveness of each measure will depend on the location and so it is expected that the description of the effectiveness of measures at the national level will include a fairly large interval. When analysed at the River basin level, the effectiveness can be estimated more precisely.

5.6. Estimation of costs

WATECO

The WATECO guidance document sets out a 5 step methodology for estimating costs, including financial and economic. It starts by estimating the direct financial costs, which include administrative costs. It then requires making transfers (such as taxes) explicit and replacing marked prices with opportunity costs. Finally, all non-priced environmental costs should be included.

All costs should be presented in terms of annual equivalent costs, on the basis of financial projections (of one-off and recurring costs) and discounting back to the year in which the analysis is carried out. As discussed earlier a range of different definitions of costs are used in the WATECO and the ECO2 groups and so a definition of the cost approach used is important.

Handbooks

The UK handbook discusses two types of cost estimations. The first is the financial costs and the second the economic or social costs. The financial costs are the private costs faced by a company. They include capital, operational, administrative costs as well as depreciation, capital charges, subsidy payments, taxes and other costs affecting the cash flow.

Economic costs, or more appropriately the social costs, include welfare losses to consumers, environmental costs, induced effects to the wider economy, transaction costs and the costs to government for administration. Environmental costs include only non-water costs and care has to be taken that they are not already internalised through taxes. It is interesting that the focus is on costs as it will often be additional benefits which are valued. Water related benefits should not be included in the CEA, but are included in CBA and a list of benefit categories to include is provided. It is noted that the economic costs will include the transfer between sectors. There is no distinction between the UK and the EU level in the discussion of economic costs. They note that what WATECO calls resource costs are more conventionally referred to as user costs or depletion costs.

It is recommended that both types of costs (financial and economic) are estimated as they both give valuable information. The cost effectiveness analysis should be based on the economic or social costs following the British Treasury's Guidelines. It is noted that the economic costs are often calculated as the Net Present Value. There are normative recommendations, which are not very precise as to how to include specific cost categories (RPA, 2004). The cost calculation is described in box 5.1 (next page).

A nine-step-procedure is proposed from looking at the problem to calculating the cost-effectiveness (see appendix 2). Along side this, a 5 step procedure is suggested to calculate effectiveness. The cost effectiveness of selected combinations is calculated and the decision is made (step 10a+b). The cost estimates are used in two places. Firstly, to screen out the least cost-effective measures so that they are not included in

the combination of measures (step 5 of the effectiveness methodology) and, secondly, in the final cost effectiveness analysis of combinations (step 10).

A key difference between financial costs and economic costs is the “transfer” costs or benefits, which correspond to a transfer of resources from one stakeholder group to another without consumption of resources (e.g. taxes and subsidies based on the Common Agricultural Policy (CAP) can be qualified as transfers). The national and the EU perspective is not discussed. Taxes aimed at internalising environmental externalities and subsidies linked to provision of environmental benefits should not be treated as a transfer. General transfers should not be considered at the regional or local level.

Box 5. The economic costs according to the UK handbook

$$PVMC_0^x = \sum_{\substack{t=0 \dots n \\ i=1 \dots m}} \beta \cdot \left(\sum_i \left\{ C_{it}^{NR} + C_{it}^R - T_{it} + [NW_{it}^c - NW_{it}^b] + [W_{it}^c - W_{it}^b] \right\} \right)$$

where: PVMC = present value of total incremental costs of adopting a measure

i = businesses/organisations affected

x = the measure under examination

t = time (in years)

C^{NR} = non-recurring costs/savings of measure

C^R = recurring costs/savings of measure

T = transfers associated with the measure

NW^c/NW^b = non-water environment costs/benefits and any resource effects

W^c/W^b = wider economic effects, as measured by changes in producer surplus and consumer surplus in related markets and not captured by estimation of direct non-recurring and recurring costs/savings

β is the discount factor $(1+r)^{-t}$

Source : RPA (2005) (Section A)

Cost and benefits not captured directly in the market, such as the non-water environmental costs and benefits, are included. The methods used for estimating these costs or benefits include willingness to pay, benefit transfer or the use of costs such as replacement costs or mitigation costs. The cost approach is appropriate when the impact is linked to national targets. Care has to be taken when the benefits are only calculated for some measure. All costs should be estimated when the knock-on effects on other economic sectors are likely to be significant or when there are different options requiring expenditure by different stakeholders. The rate of discounting is 3.5% which

goes down to 3% in year 31 and 2.5% in year 76. The discounting for non-water environment at costs and benefits reflects the social rate of time preference as individuals place more importance on the present than the future.

The German handbook distinguishes between direct and indirect costs, but not between financial and economic (social) costs. The direct costs or the operational costs are as a rule born by the executing authority. These include construction costs and administrative costs in relation to the implementation of an instrument. The indirect costs or the economic costs are typically not borne by the executing authority but by other players. One example is the loss of revenue for farmers when they have to change their production and could also include secondary effects on suppliers, etc., but this will often be left out as it requires extensive modelling. As it might be time consuming to evaluate these costs, it should only be done if it is important for the selection of measures if the indirect costs are significant. The costs are calculated either as annual costs or present value and the interest used is 3%. The measures are grouped and then evaluated. The indirect costs are evaluated as being low, moderate or high. In using this approach, the indirect costs for farmers are often not calculated in much detail.

In the Dutch handbook, costs include investment, operation and maintenance costs. All costs are expressed in annual terms. Economic costs, such as loss of employment or indirect effects would be described once the most cost effective package has been selected. It is recommended that indirect effects be taken into account only in the assessment of disproportionate costs.

The Danish perspective

The Danish cost definitions presented in chapter 3 follow the recommendations included in the WATECO document, including both direct and indirect costs (see also table 3 in chapter 6).

None of the other EU-countries in this comparison seem to use standards such as the levy factor or the tax distortion factor, which can make comparisons across countries difficult. As mentioned earlier the rate of discounting of 6% used in DK is higher than e.g. the UK level. Otherwise the Danish cost is similar to the British description. Although the Danish approach has been used in several Danish cases clarification on the approach to be used in the water plans at the municipality level is important.

5.7. Assessing cost effectiveness

WATECO

WATECO simply recommends that measures be ranked according to the cost per unit. They do not recommend ways of combining measures based on the evaluation of single measures.

On the combination of environmental and economic modelling, the conclusions from the Amsterdam Workshop in 2004 indicated that the Gap-analysis carried out in Impress “does not provide a sound basis for the environmental costing procedure. A fully integrated environmental costing procedure will therefore not be feasible”. (Brower and Strosser, 2004). Others have stated that there are uncertainties regarding estimates both with respect to environmental and economic parameters and that there is a need to integrate the two perspectives (BMU, 2004).

Handbooks

The UK handbook does not recommend presenting a single indicator of cost-effectiveness as too much information will be lost in such a process. Instead, packages including more measures are analysed based on an assessment of the effect obtained, the scale, the certainty, adaptability, practicability and side effects. Also, the monetary and non monetary costs are included in this analysis. The focus is on pair-wise comparisons, building on the most cost effective programmes of measures. How to weigh together the different attributes of each measure is not clear. The methodological description points out that the “best” combination of measures will depend on the level of risk that is acceptable. In the cases shown, the costs are estimated as £ per kg P. The river basins include the effect of a national nutrient surplus charge on P and a Ban on P in detergents together with some regional measures. This part is not discussed in very much detail in the UK handbook.

Also, the German handbook finds that the selection of the most cost effective measures should not be done based on one single indicator, but rather on the basis of trade offs between the probability of target achievement by 2015, the ecological effectiveness of the measure and the indirect economic costs. The effectiveness of a combination of measures is estimated based on the interactions between measures. The first cost-effectiveness ranking should be based on primary effects postponing the use of secondary effects to a later stage in order to reduce the complexity. When selecting the most cost-effective combinations a trade off between e.g. the time frame and the

costs of reaching the target should be considered. The case examples are based on a procedure where the cost efficient measures are combined in 2-3 ways and where the choice is between these packages.

The Dutch handbook recommends prioritising the measures based on their cost effectiveness using one indicator (e.g. yearly costs per kg P or eutrophication unit). A package of measures can be compiled by selecting the measures required to fulfil the targets starting with the most cost efficient. They also note that the cost and effects of mutually dependent measures are not just the sum of these measures. They recommend that the interdependence between measures is noted. The cost effectiveness analysis does not pay attention to the extent to which various sectors contribute to the problem and so the sector which contributes the most might not be the one which reduces the most if the reduction is more cost efficient in other sectors. In the case of the Rhine described in the handbook they deal firstly with N, then copper and then P. When the final package is put together they experience that some pollutants are reduced more than required. This leads to the question of whether it is possible to have a partly implementation of some measures based on a total assessment of the whole package in order to avoid overachievement.

The CIS group concludes that a single indicator for cost effectiveness has the advantages of simplicity and can help prioritise measures in a transparent manner. A multi-dimensional criteria approach may result in the trade offs not being very explicit. This approach would require a multi-criteria approach where the weights for the main attributes were agreed upon by all the stakeholders.

The Danish perspective

The Danish analyses have so far focused on one single cost-effectiveness indicator based on the annual costs divided by the annual effects (N) in line with recommendations. It is likely that future analyses will be based on eutrophication equivalents as the effect on phosphorous losses soon can also be estimated. The interdependence between measures can be solved both by describing the connection and by developing new packages of measures, where the interdependence has been taken into account.

The factors included in e.g. the UK cost effectiveness assessment contain more information, but, at the end of the day, some weights for each attribute have to be determined anyway.

The recommended procedure is to base the cost-effectiveness on one single indicator (e.g. eutrophication equivalents). The ranking should be performed both with and without additional effects such as CO₂-emissions, NH₃ losses, etc. Based on this calculation a package of measures can be compiled and they can then be evaluated more thoroughly including issues of interdependency between measures and effects on other sectors, etc. This double loop-analysis will take longer and might therefore not be possible in the first planning period.

5.8. Uncertainty

WATECO

The Wateco guidance recommends that care be given to the cost estimates. The uncertainty affecting the cost estimates as well as the effectiveness, will affect the cost effectiveness and the ranking. It is recommended to carry out sensitivity analysis to estimate the robustness of results.

Handbooks

The UK handbook recommends a description including type of probability distribution (rectangular, triangular or normal) and lower and upper bounds of uncertainty around the most likely estimate of effect for each measure. Testing this approach in the UK has shown that the methodology is too subjective and that creating a probability distribution requires too many assumptions. When data is limited it is recommended to carry out the analysis with less detail. The newest recommendation is to characterise uncertainty with two parameters namely reliability and accuracy (based on 4 /5 levels, respectively). This is also used to assess whether more information is required in relation to the analysis in hand.

The German handbook does not address the issue of uncertainty in detail, whereas the Dutch handbook recommends the use of ranges with lower and upper estimates pointing out that reliable estimates should be available for measures which have been introduced before. They also recommend the use of sensitivity tests based on the lower and higher estimates to the impact on the ranking of measures.

The Dutch handbook states in a case analysis that there is a great need for both ecologists and economists to dare to make rough estimates concerning the potential costs

and effects of measures. As they say “If we leave the analysis of possible packages of measures until all details are known, the objectives will never be realised in time”.

The Danish perspective

The focus is on uncertainty, but sometimes it could be useful to distinguish between risk, where the probabilities can be estimated and uncertainty, where the probabilities can not be estimated. Judging from the handbooks this difference is not given much attention.

In the Danish analyses so far the use of a medium value, or the use of intervals of costs has been applied according to the recommendations made in the Netherlands. The same approach has been adopted with respect to effectiveness.

These intervals might result in relatively large intervals with respect to cost-effectiveness as they are based on an interval from lowest cost/highest effect to highest cost/lowest effect. This could make the ranking process more difficult. Such an interval could be supported with a description of the probability distribution, but this might often be difficult to estimate.

The uncertainty with respect to cost and effectiveness will in some cases be related to regional differences. National estimates of cost-effectiveness for a given measure will therefore have a larger interval than for a selected river basin or sub basin.

In the political process the medium value is often preferred, but the underlying analyses should reflect on the uncertainty involved and the factors which might change the estimates of cost and effect. Sensitivity analysis would prove how robust the ranking of measures is e.g. related to differences in the effect of P-losses where the uncertainty is larger than for N-losses.

5.9. Involving experts and the general public

WATECO

The WFD (article 14) promotes the active participation of all interested parties in the development of River Basin Plans. Stakeholders can be involved at different stages in the process. The document recommends involving experts at several stages of the economic analysis including assessing the effectiveness and the costs. Stakeholders can be a useful source of information of direct use for the economic analysis. The

public can be involved in the process in order to develop a sense of ownership and may increase the effectiveness of measures.

Handbooks

The UK handbook recommends stakeholder participation in five steps including problem definition, identifying measures, predicting effectiveness, developing combinations of measures and comparing combinations of measures. Experts are involved when there are significant gaps in knowledge.

The German handbook concludes that early consultation should lead to greater efficiency when selecting measures. Experts are required to evaluate correlation between measures, to determine economic costs and to weigh the various decision-making parameters.

The focus in the Dutch Handbook is also on transparency in relation to methods used. Only if a simple approach is used can the process be followed directly by everyone. A preference is given to the use of available knowledge in a pragmatic way in order to find an effective solution as opposed to a less transparent model which is theoretically optimal. Their recommendation is a simple method which is practical and transparent.

In the summary, the CIS document points to the fact that although the documents describe intentions they have not defined the procedure of how this participation should be carried out. This also holds for the issue of resolving conflicts between different stakeholders.

The Danish perspective

Based on the experience with the Danish Actions Plans it is relevant that stakeholders e.g. the agricultural sector are consulted in the process of developing measures and the estimation of costs. The agricultural sector has expert knowledge on both effectiveness and costs which should be included in the analysis. This could be done by a process where e.g. the cost effectiveness catalogue is discussed with stakeholders.

Stakeholder participation can be important for an acceptance of the ranking of measures proposed for a given sector. The participatory approach ensures that more dimensions of the problem and the solutions are included, but it makes the process more complex and a complete agreement between all stakeholders on measures and costs is not likely.

5.10. Link with disproportionate costs

WATECO

The cost estimates used for the cost-effectiveness analysis is a starting point for calculating the costs with respect to disproportionate costs. This could e.g. include the costs for other sectors.

Handbooks

The UK handbook recommends that information on costs be collected in a comprehensive manner during the CEA to cover analysis of who pays and the disproportionate cost analysis. It is concluded that some additional information will probably be required. The disproportionate costs can both be a comparison of social costs with social benefits or can look at the costs across sectors or river basins.

The Dutch handbook stresses the iterative process related to the cost-effectiveness analysis and the later analysis of disproportionate costs. It is pointed out that the CEA will be carried out several times during the implementation of the WFD.

The Danish perspective

It seems likely that although the cost estimates will be the foundation some additional cost analyses might be required with respect to the issue of disproportionate costs. A steep increase in the cost-effectiveness ratio would indicate disproportionate costs. These cost estimates can then be compared with the benefit estimates in order to evaluate the issue of disproportionate costs. It seems likely that the CEA will be able to point to water bodies where the issue of disproportionate costs is relevant, but if the benefits vary from e.g. lake to lake then the issue is more complex. How to single out the costs and the benefits specifically related to a single water body might be difficult as it might be related to other water bodies.

5.11. Key challenges when working with CEA analyses

The CEA report on costs effectiveness finishes with some preliminary conclusions based on the analysis presented above (CIS, 2006a):

1. It is important that the cost-effectiveness framework is simple and concrete starting with financial costs and efforts.
2. CEA methodology is complex; therefore we need to make it clear that communication and proper training will be crucial to implement CEA correctly.
3. There is no integrated CEA methodology in Europe at this time which allows the integration of both multi-sectorial (household, agriculture) and multi-parameter dimensions (diffuse pollution, point pollution, etc.).
4. Some catalogues for costs and benefits do exist.
5. The link between cost effective analyses and disproportionate cost/exemption is not clear.
6. Many countries aim at compiling a handbook on cost effectiveness ready by the summer 2006.

A summary report on the cost effectiveness methods was presented at the Water Directors Meeting on the 1-2 June 2006 (CIS, 2006b). The key issues identified for further development include:

- Sharing information on cost effectiveness studies
- Development of a step by step procedure
- Transboundary issues – comparability
- Case studies on practical approaches for CEA
- Measure – effect relations
- Uncertainty
- Link to disproportionate costs

The commission states that costs-effectiveness assessment should be coordinated within river basin districts and Member states. The appropriate scale of application of assessment may be different for different issues (Commission, 2005). But, it is stated in the CEA summary paper that a single approach to **CEA is not desirable or expected** bearing in mind that many member states have not developed CEA methodologies. The number of countries which have tested the methods in real life is even smaller. It is highlighted that there is a need for “a harmonised, comparable and transparent approach for the application of the “exceptions””.

6. Discussion of the foundation for future CEA in Denmark in relation to the WFD

This section deals with some of the key issues which have to be discussed in the further implementation of CEA analyses related to the WFD in Denmark. The discussion is also related to how to carry out CEA inside the deadlines described in the WFD.

The first notion is that carrying out a cost effectiveness analysis following the many recommendations and dealing with the problems discussed in this report is not an easy task and that it takes time.

6.1. The cost effectiveness method

It is recommended that the welfare economic approach described in chapter 3 is used to estimate the annual costs for a given measure. The use of the methods will require some guidance for the analyses to be preformed in the same way in the different environmental centres across the country.

The interest rate used is 6%, but a sensitivity analysis using 3% is included to show how much difference the interest level has on the ranking of measures. The interest rate of 6% is higher than that used in some other EU countries. In Denmark work is underway at both the Ministry of Finance and The Ministry of Environment to find which interest rate should be used in future project calculations.

As the budgetary costs are important for a discussion of the financial implications it is required that these costs as well as the welfare economic costs, are presented for each measure.

For each measure it is assumed that the effect is reached within the deadline although some will have an effect sooner than others especially when the effect is measured in the recipient.

Preliminary analyses carried out by the counties suggest that many streams, lakes and fjords will not reach the target by 2015. Although the focus in the WFD is the individual waterbody then a required reduction covering most of the country could imply that national measures might be cost effective to introduce as the risk of over implementation in some water bodies in relation to the WFD is limited.

Such measures might include reduced N-application, catch crops or set-a-side in environmental sensitive areas or along streams and rivers. The effect of national measures would have to be included in the regional analyses before deciding whether they are required additionally.

As described, the cost method will vary from country to country so cost, etc. will not be directly comparable. It is therefore important to describe the method used (see table 3).

The conclusion is that the items included in the Danish definition of welfare economic cost include at least the same items as in other economic cost definitions in other European countries. It seems that the Danish guidelines (Møller et al., 2000) on how to perform these analyses are more detailed and therefore allow for a clearer usage of the different cost items in different projects. In other countries there seems to be some difference between what is intended and what is actually included in the analyses so far.

Table 3. Summary of costs included in different descriptions of the economic/welfare economic costs in CEA in relation to WFD			
	WATECO	UK	DK
Direct costs	Included	Included (financial costs)	Included (budgetary costs)
Adjustment for subsidies and taxes	Perhaps Included	Included	Included
Price adjustment (factor price -> consumer price)	Not discussed	Not included	Included
Consumer surplus	Not explicitly included	Discussed but not included	Included
Administrative costs	Perhaps	Discussed but often not included (regulatory costs)	Discussed but often not included
Associated non-water environmental costs and benefits of measure	Included	Included when possible	Included to some extent
Wider economic effects in other sectors (income and jobs)	Partly discussed	Discussed but often not included	Discussed but often not included
Total costs is named	Economic costs	Economic costs or Social costs	Welfare economic costs

Source : Based on RPA (2004) and own interpretation see chapter 3.

* WTP = willingness to pay

Although the Danish description is more straightforward, some considerations and guidelines as to which of the cost items should be included is required. This will ensure a consistency as the analyses might cover costs where the data might be hard to come by. This would suggest that items like administrative costs, non-water costs and benefits as well as wider economic effects should perhaps not be included in the first round of cost calculations.

Several countries discuss the issue of whether the economic analysis at the regional level should be carried out by economists or general administrators. So far much of the analyses in the different countries have been carried out by economists employed at different consultancy groups or research institutes. In writing the future guidelines for CEA analyses in Denmark this issue will have to be taken into consideration.

It is required that stakeholders participate to get the best cost estimates and have the opportunity to comment on the output before it is used on a wider scale. In the UK case they have used standard national costs data (look up tables) in order to give a first estimate of the costs for each river basin based on a selection of measures.

6.2. Phases and challenges

It is assumed that the Danish Environmental Agency will have to produce some guidelines for the new environmental centres which will be established in January 2007.

In connection with the guidelines, a catalogue of measures with estimates of costs and effects should be presented. This catalogue could be based on the work in the present project group. The overview could be supplemented with an appendix of the actual calculation and a computer programme so that local factors can be entered and used when making the ranking.

The lesson learned from e.g. Odense Fjord and Ringkøbing Fjord is that both calculations and the later process take time. In both cases it has taken more than 2 two years to pass the actual plans based on the analyses.

In this process the link with the environmental modelling is also important. In order to be able to come up with some preliminary plans within the given timeframe it could be suggested that the process be split into two phases based on two levels of detail.

Phase **one**; where the requirements in the water basin level are determined and a range of measures are suggested to meet the objective. In this phase the possible measures are introduced based on national analysis and the possible total area for a given measure is evaluated. It is ensured that the required environmental data is in place, but measures are not located geographically and the costs are not necessarily related directly to the given river basin. The analysis of measures is partial as described by Funen County in their analysis from 2005. It is estimated by the Environmental agency that 25-30 river basin analyses would be enough to cover all of Denmark.

A **second phase** would then tackle the actual implementation dealing with issues such as:

- The **spatial dimension** and the **maximum area** of a given measure in the sub river basin
- The **combination of measures and their interdependence (package of measures)**
- The **time dimension** (when will the change the water quality occur)
- The **multiple aims** covering both lakes, streams, fjords and groundwater (up/down stream)
- The implementation of measures and **administrative costs**
- The **financial burden (who is paying?)**
- The likely **side effects** in relation to other environmental goals as well as impact on national income and employment
- The possible **decreasing cost efficiency** for a given measure
- **Sensitivity analyses** on the ranking (uncertainty and the inclusion of additional effects)
- Possible areas where **disproportionate costs** should be analysed

There is a need to develop a uniform approach to cost effectiveness analyses in Denmark and the report shows that there is a range of issues which need to be addressed in such a guideline. The guideline will have to develop a framework for the economic analysis at the regional level supplemented with a catalogue of measures and potential costs.

Also more effort at the national level is required to participate in the discussions concerning the EU-guidelines with respect to CEA analyses at the EU-level. This would also give a better foundation for future discussions regarding disproportionate costs.

Sammendrag

Når vandrammedirektivet (VRD) skal implementeres, bliver en af de største udfordringer at finde virkemidler til at opfylde målet. En omkostningseffektivitetsanalyse er en metode, der sikrer at målet i det enkelte opland opnås med brug af de mest omkostningseffektive virkemidler.

En omkostningseffektiv rangordning af virkemidler er forholdsvis simpel, når der er tale om et mål og en kilde til forurening (fx kvælstof). Imidlertid viser case studier i Danmark og anbefalingerne fra andre EU-lande, at proceduren med at finde de mest omkostningseffektive virkemidler ikke er så let, når der er flere mål, sideeffekter og forureningskilder.

Analysen i denne rapport er baseret på de officielle EU-guidelines, danske erfaringer om planlægning i oplande og ideer og tanker præsenteret i en række håndbøger fra andre EU-lande omfattende vigtige områder, hvor yderligere afklaring er nødvendig i relation til omkostningseffektivitetsanalyser. I rapporten er anbefalingerne sammenholdt med den danske tilgang til problemet. Rapporten er del af en større udredningsopgave udført for Komiteen for en langsigtet planlægning af det danske vandmiljø under ledelse af Finansministeriet ved kontorchef Niels Gotfredsen.

De officielle vejledninger om omkostningsbeskrivelse fra tidligere EU arbejdsgrupper har ikke givet en særlig klar beskrivelse af, hvad der præcist er inkluderet i omkostningsopgørelsen. Det er konkluderet, at der skal estimeres to typer af omkostninger, nemlig de velfærdsøkonomiske omkostninger og de budgetmæssige omkostninger. De velfærdsøkonomiske omkostninger beskriver omkostningerne for samfundet, hvorimod de finansielle eller de budgetmæssige opgørelse beskriver, hvem der betaler omkostningerne. Det er også disse to typer omkostninger der nævnes i de europæiske analyser. Undersøgelsen viser, at det er vigtigt med en detaljeret beskrivelse af hvordan omkostningerne beregnes. I det tidligere arbejde i relation til VRD har der været meget fokus på miljø og ressourceomkostninger, der også kan ses som et tab af gevinster. Disse omkostninger er primært relaterede til prissætning af vand i vandforsyningen, og de indgår ikke i den omkostningsdefinition der anvendes her.

I de danske beregninger af omkostninger og indkomstændringer indgår både investeringer og løbende omkostninger. Omkostningseffektiviteten er beregnet som de årlige omkostninger divideret med den årlige miljøeffekt. Hvad angår diskontering så er valg af rente et vigtigt element. Som udgangspunkt er den anvendte realrente 6%, både

hvad angår de velfærds- og budgetøkonomiske omkostninger i Danmark. En følsomhedsanalyse med brug af en rente på 3% er foreslået. I den velfærdsøkonomiske beregning er omkostningerne omregnet fra faktorpriser til forbrugerpriser med brug af faktoren 1,17 eller 1,25 afhængigt af om varerne er omsat nationalt eller internationalt. Endvidere kan omkostningen multipliceres med en faktor 1,2, der dækker skatteforvriddningstabet, hvis det pågældende virkemiddel er afhængigt af offentlig finansiering og skattefinansiering.

Sideeffekter eller afledte effekter dækker fx ammoniak, CO₂ og andre benefits, som kan indføjes i analysen. Disse effekter er ikke målet i VRD, men de kan være målsat i anden national eller europæisk lovgivning. Specielt er det vigtigt at sikre at sideeffekterne er beregnede for alle virkemidler, således at datatilgængelighed ikke påvirker rangordningen. Det foreslås derfor at rangordningen beskrives både med og uden sideeffekter. De øvrige økonomiske effekter vil typisk ikke indgå i analyser på oplandsniveau, men vil kunne indgå på regions- eller vanddistriktsniveau. Endelig, vil de administrative omkostninger sandsynligvis ikke blive inkluderet i beregningerne på oplandsniveau, men nogle generelle niveau for de administrative omkostninger kan anvendes, når arealrelaterede og bedriftsspecifikke virkemidler skal sammenlignes.

Erfaringer fra tidligere vandmiljøplaner viser, at det tager længere tid end forventet at nå de miljømæssige mål. Effekter og omkostninger ved tidligere vandmiljøplaner er blevet evalueret, og dette vil muliggøre en bedre estimering af både effekter og omkostninger i fremtidige projekter. Fokus i Danmark har hidtil været på kvælstofudvaskningen fra rodzonen, men i fremtidige analyser vil det være næringsstoffetabet til vandmiljøet der opgøres. Dette vil gøre opgørelserne mere usikre, idet der er stor forskel på, hvor meget af næringsstofferne, der forsvinder på vejen til vandmiljøet. Dertil kommer, at det i nogle tilfælde vil det tage mere 10 år før virkemidler vil have effekt i den pågældende vandforekomst.

Brugen af omkostningseffektivitetsanalyser på nationalt niveau har vist, at rangordningen kan give et grundlag for den endelige beslutning, men den endelige beslutning er et politisk valg. Det er sandsynligt, at det også vil være tilfældet når handleplanerne i kommunerne skal udmøntes.

De tidligere analyser i Danmark har også vist at:

- Det er vigtigt, at der er en klar sammenhæng mellem mål og udmøntningen af et givet virkemiddel. Overlap og interaktion mellem virkemidler kan påvirke både effekt og omkostninger.
- Den administrative implementering af et givet virkemiddel kan ændre både omkostninger og effekt.
- Vandplaner for det enkelte opland skal søge at nå mål både hvad angår grundvand og vandkvalitet i vandløb, søer og kystvande.
- Omkostningseffektivitetsanalysen på oplandsniveau er en lang proces og der kan godt være behov for at virkemidler og sammensætningen af disse analyseres flere gange (2-3 år er sandsynligt).
- En trinvis proces kan anbefales for at nå en omkostningseffektiv vandplan for et opland, således at det også bliver gennemskueligt for andre interessenter. Proceduren kan være at starte med virkemidler rettet mod grundvand, så søer, vandløb og endelig kystvand.
- Den geografiske placering af virkemidler påvirker både effekt og omkostninger.
- De anvendte nøgleindikatorer omfatter næringsstoffab. I relation til VRD vil fokus i vandløb være fysiske forhold og vandmængde, fosfor i søer og kvælstof og fosfortab til kystvande. Det er muligt at eutrofieringsequivalenter kan være den fremtidige indikator i kystvande. Vandmangel er et mindre problem i Danmark i forhold til mange sydeuropæiske lande.
- Det vurderes at hovedparten af alle vandløb, søer og kystvande ikke vil kunne leve op til målene i 2015. Hvis der er samme afstand mellem nuværende tilstand og ønskede tilstand for alle vandforekomster, kan det overvejes at anvende generelle virkemidler. Hvis der er en variation i afstanden til målet, så vil stedspecifikke virkemidler være mere relevante.

På europæisk niveau vurderes de største udfordringer i relation til omkostningseffektivitetsanalyser og VRD at være følgende:

- Hvordan håndteres opstrøms- og nedstrømforhold, når de miljømæssige effekter og omkostninger skal fordeles mellem kommuner, regioner og lande.
- De første vandplaner inkluderer måske ikke en grundig omkostningseffektivitetsanalyse grundet mangel på data og metoder.
- En detaljeret beskrivelse af både virkemidler (hvilken adfærd ændres) og de anvendte mekanismer (hvad gøres der) er nødvendig for at kunne beregne effekt og omkostninger.
- Fokus i VRD er på de supplerende foranstaltninger, men i nogle sammenhænge vil det være relevant at inkludere de grundlæggende foranstaltninger, som måske Vandmiljøplan III, i analyser af disproportionale omkostninger, da de delvist har opfyldelse af VRD som mål.
- Opfyldelse af Nitratdirektivet og Habitatsdirektivet kan være svært at adskille fra andre VRD, og det kan godt påvirke både effekter og omkostninger.
- En forundersøgelse af relevante virkemidler er vigtig i lande hvor virkemidler sammenlignes parvis for en lang række parameter.
- Omkostningsdefinitionen varierer fra land til land, så det er vigtigt at beskrive hvorvidt skatteforhold, sideeffekter og administrative omkostninger indgår i analysen.
- Nogle gange svarer ambitionerne i nationale vejledninger ikke til indholdet i de faktiske analyser på lokalt niveau. Det er vigtigt at ambitionen i vejledninger svarer til det der er muligt på oplandsniveau.
- Et nationalt katalog over virkemidler og omkostninger anbefales som et første trin, men omkostninger og effekt for samme virkemiddel kan variere en del fra område til område.
- Nogle lande fokuserer på næringsstoffabet mens andre finder, at brugen af én indikator er for snæversynet, hvorfor de bruger flere indikatorer.
- Rangordningen af virkemidler er i nogle lande baseret på flere parametre, men ofte er afvejningen mellem de mange indikatorer ikke særlig tydelig.

Den vægtning, som tilskrives den enkelte indikator skal vises eksplicit for at andre kan deltage i beslutningsprocessen.

- Hvad angår usikkerhed så synes et interval at være det mest sandsynlig, hvorimod en sandsynlighedsfunktion kræver for mange data. Følsomhedsanalyser for nøgleparametre anbefales for at se hvor robust rangordningen er.
- Det at involvere eksperter og offentligheden kræver at resultater diskuteres i processen omkring udformningen af indsatsprogrammet. Det tager tid, men det kan hjælpe til en bedre forståelse og accept af de virkemidler som skal implementeres, specielt lokalt.

Der vil ikke i den nærmeste fremtid være en fælles tilgang til omkostningseffektivitetsanalyser i EU, men det er vigtigt at arbejdet i EU-følgegruppen omkring disse analyser kan fortsætte. Dette kan sikre en større dialog om implementeringen af omkostningseffektivitetsanalyser. Når der kommer flere vejledninger og praktiske erfaringer, vil det være muligt at beskrive minimumsindhold for disse analyser. Det kan konkluderes, at den danske tilgang til omkostningsberegninger er fuldt ud acceptabel, når der sammenlignes med andre EU-lande.

Det anbefales at implementeringen af omkostningseffektivitetsanalysen sker i to faser, hvor første trin er fokuseret på at få databeskrivelserne på plads og vurdere de mulige virkemidler for grundvand, vandløb, søer og kystvande hver for sig på oplandsniveau. Dette kan gøres for alle 20-25 oplande i Danmark, og det vil give en første beskrivelse af de faktiske omkostninger ved at nå målet baseret på regionale analyser.

Den næste fase vil omfatte en mere detaljeret analyse med stedspecifik placering af virkemidler på deloplandsniveau, hvor alle interaktioner mellem virkemidler angives.

I lyset af den opgave der skal løses og den relative korte tid der er til rådighed, er det vigtigt med en større indsats for nærmere at beskrive hvordan omkostningseffektivitetsanalyserne skal laves på oplandsniveau. Vejledninger til folk der skal arbejde med dette på regionalt niveau vil skulle udarbejdes i løbet af 2007. Det ville også være værdifuldt for Danmark at deltage aktivt i den fremtidige proces omkring omkostningseffektivitetsanalyser på EU niveau, da dette vil være et centralt input til den fremtidige brug af cost-benefit analyser og diskussionen om disproporportionale omkostninger ved implementeringen af VRD.

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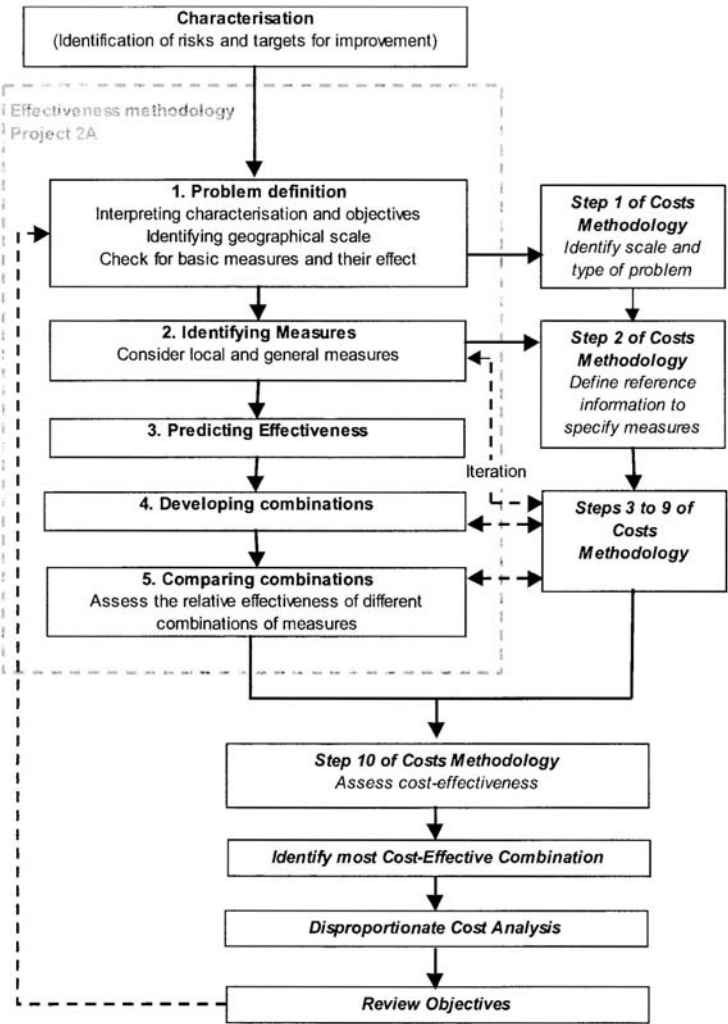
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Appendix 1: Calculation of land rent in Denmark

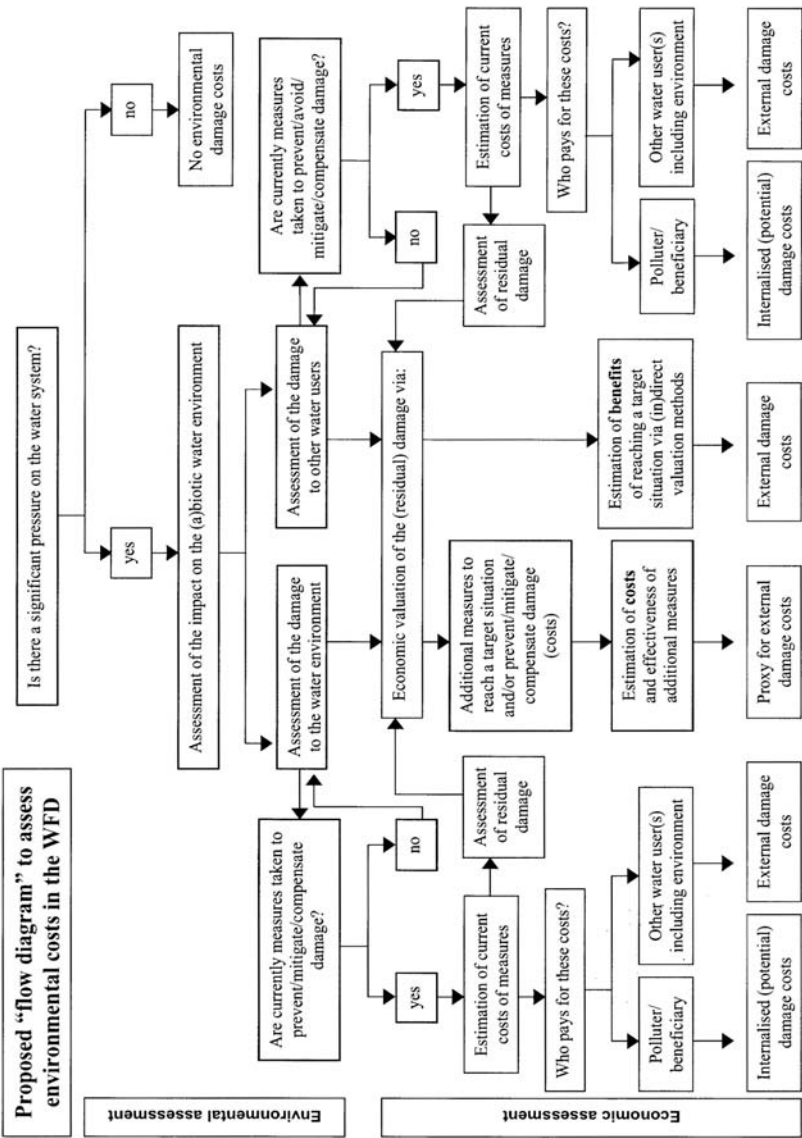
Budget calculation	Welfare calculation
Gross margin I	Gross margin I
- Semi variable costs	- Semi variable costs
Gross margin II	Gross margin II
+ Single payment and subsidies (all transfers)	+ Single payment and other subsidies (only transfers from EU)
- depreciation on buildings and machinery	- depreciation and interest on buildings and machinery
- interest on livestock capital	- interest on livestock capital
- estimated cost for unpaid labour (family)	- estimated cost for unpaid labour (family)
- financial costs	
- Taxes and levies	
= Land rent (factor prices and budget economic interest)	= Land rent (welfare economic prices and interest)
Source : FOI Accounting statistics and Schou and Abildtrup (2005)	

Appendix 2. Flow diagram to assess cost effectiveness based on UK guidebook



Source: RPA, 2005

Appendix 3. Flow diagram to assess environmental costs proposed by ECO2



Source : Brower and Strosser (2004)